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ABSTRACT

This curriculum guide contains 10 units that provide the basic curriculum components required to develop lesson plans for the industrial equipment maintenance curriculum. The guide is not intended to be a complete, self-contained curriculum, but instead provides the teacher with a number of informational items related to the learning outcomes and allows the teacher flexibility to design instructional activities, select resources, and deliver instruction most appropriate for the learner and learning environment. The units of instruction contain the following components: learning outcomes; associated tasks; performance standards; lists of tools, equipment, resources, and limiting constraints; performance steps; and enabling objectives. The units cover the following topics: industrial mechanics; hydraulic/pneumatic systems; crane elevators; electrical equipment; welding; plumbing; drill presses; grinding; turning; and maintaining equipment. A list of equipment to be carried in an industrial equipment maintenance standard tool kit completes the guide. (KC)

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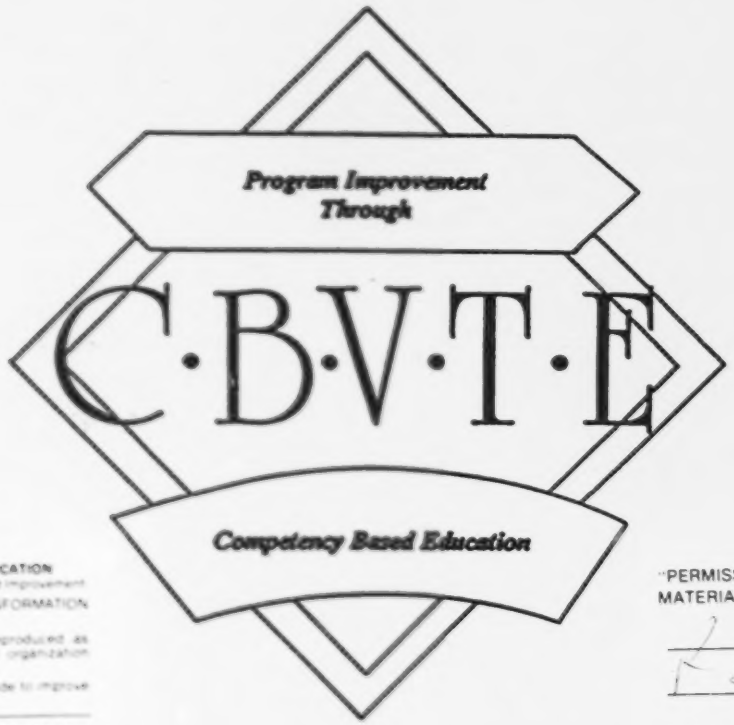
VOCATIONAL EDUCATION CURRICULUM GUIDE

INDUSTRIAL AND TECHNICAL EDUCATION



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Preface

The concept of competency based vocational-technical education has been supported by the Bureau of Vocational, Technical and Adult Education for a number of years. Since the early 1970's, the State has sponored the development and dissemination of numerous competency based curricula through the State Vocational Curriculum Laboratory. With the recent development of the State Master Plan for Public Education, however, the need to move rapidly toward systemwide adoption of this instructional concept in all schools is mandated by State Board of Education Policy.

According to the State Master Plan for Public Education, all instructional programs are to be learner oriented and described in terms of high quality, measurable, student centered outcomes (learning outcomes). In essence, this policy reinforces the competency-based vocational education philosophy.

Consistent with our current efforts in encouraging the implementation of vocational education learning outcomes, we have prepared this curriculum guide to assist vocational teachers as they prepare lesson plans that are reflective of the mandated core curriculum and defensible in terms of an equitable, quality vocational program.

Additional copies of this curriculum guide may be obtained from the:

West Virginia Vocational Curriculum Laboratory
Cedar Lakes Conference Center
Ripley, West Virginia 25271
Telephone: (304) 372-7021
Toll Free: 1-800-WVA-JOBS (in state)

Any suggestions you have for improving this material may be sent to your Vocational Curriculum Laboratory. Through this feedback, we plan to continually update and revise our materials.

VOCATIONAL, TECHNICAL AND ADULT EDUCATION

Clarence E. Burdette
Assistant State Superintendent of Schools

Overview

The contents of this guide provide the basic curriculum components required to develop lesson plans that address the learning outcomes for this particular area of study. As such, this guide is not intended to be a complete, self-contained curriculum. Instead, the teacher is provided a number of informational items related to the learning outcomes and allowed the flexibility to design instructional activities, select resources and deliver instruction most appropriate for the learner and learning environment.

Specifically, this curriculum guide is organized in the following manner:

Units of Instruction (Where applicable)

A unit of instruction is a group or cluster of related learning outcomes that have been placed together for their similarity or main idea of task accomplishment. An example of a Unit would be Shielded Metal Arc Welding within the welding and cutting area of study.

Learning Outcomes

A learning outcome, oftentimes synomous with a competency statement, is a concise description of the curriculum in terms of desired learner behavior. Such statements are measurable, may contain one or more tasks and be action oriented. All approved learning outcomes for vocational education have undergone a strigent verification process with input from teachers and representatives of the business and/or industrial sector.

The approved learning outcomes for a specific vocational education area of study represent the core competencies of what has been identified as a quality vocational education experience. They do not, however, represent the entire instructional program for any area of study. It is hoped that all vocational instructors and local educational agencies will provide learners with educational experiences that exceed the "core competencies" identified through the learning outcomes.

Associated Tasks

A task represents an identifiable behavior that (1) has a purpose; (2) has a definite beginning and ending; (3) contains two or more steps none of which is a restatement of the original task statement if in the psychomotor domain; and (4) has a standard of performance which can be defined, described and verified. Learning outcome statements may be on the task level or may contain two or more independent tasks.

Examples of task/behavior statements are:

1. Chase external pipe threads.
2. Bleed diesel fuel system.
3. Use common standard medical abbreviations.
4. Prepare a resume.
5. Plan food experiences suitable for young children.

Performance Standards

The Standard is defined as criteria for assessing if tasks are performed or demonstrated as either acceptable or unacceptable. The performance standard communicates to the learner the quantity and quality of how well he or she is expected to complete the task. The standard can be stated in terms such as actual percentage of achievement, the accuracy expected, the number of errors permitted, the time allowed to complete the task, the degree, or any other appropriate level at which achievement is anticipated. The standard should be based on the performance level needed on the job.

Examples of standards are:

1. The circuit board must operate within the tolerances of the circuit design.
2. The estimate must be within + or -5% of that figured by the instructor.
3. Contacts must open when more than 125% of rated current value is made to pass through the overload relay heating element or coil.
4. The installation must be complete and each conductor must be terminated according to the schematic drawing of the design.
5. The motor must carry the load without being overloaded; the directions of rotation must be correct; belt must have a deflection of between 3/8" or 1/2".

Tools, Equipment, Resources and Situation(s)

Situation(s) is defined as the limiting constraints under which actions are to occur. The circumstances or restrictions imposed on the learner when he or she is demonstrating the behavior must be defined. Frequently, the conditions identify the testing situation used to determine learner achievement of the standard. Tools and equipment are the materials needed to perform the task being addressed in each performance standard.

Performance Steps

Performance steps are a series of steps required to perform a psychomotor task. The steps (1) are arranged in the sequence ordinarily followed on the job, (2) have a concise start and close, (3) are limited to the accompanying task statement, and

(4) are self-supporting and do not refer to actions beyond the task performance. Performance steps developed for each task are used to determine the enabling objectives and steps and procedures for performance checklist(s) to be utilized in assessing learner mastery of the task.

Enabling Objectives

Enabling objectives reflect the knowledges, attitudes and related skills the learner must possess in order to complete the task to the specified standard(s). As such, enabling objectives are derived from an instructional analysis of the task and/or performance steps and are stated in measurable terms of student performance.

Terms such as "define verbally," "construct," "diagram" and "list" are used to express enabling objectives, rather than obscure verbs like "know," "learn" and "understand". Examples of acceptable enabling objectives are:

1. List verbally the parts of a voltmeter.
2. Define Ohm's Law.
3. Explain relevant safety precautions and procedures.
4. Discriminate between types of life insurance policies.

Given this information for each outcome statement, the instructor is encouraged to develop the following components for lesson planning, delivery and evaluation.

Develop Instructional Activities

Instructional activities should be designed to provide the learner with experiences related to the enabling objectives, cumulating in successful task performance. The instructional activity section of a curriculum should contain a variety of strategies designed for the learners' varying learning styles and rates.

Consideration should be given to age, ability levels, educational levels, varied learning styles, individual interests, career goals, and emotional needs when developing the instructional activities. Activities should include suggestions for large groups, small groups and individual methods. The use of small groups may help students attain the skills, knowledge and attitudes associated with each task by making them (1) feel adequate and physically competent when they lack the necessary background information and experience; (2) feel a sense of security through the reenforcement of positive group attitudes; (3) gain confidence and discover that they are an essential part

of a team engaged in the learning-teaching process; (4) learn to work without direct supervision, and (5) vary instructional routines away from lecture or other full-class methods.

Identify Appropriate Instructional Resources

Instructional resources should be identified for each instructional activity and should be designed to help convey the message of the task and enabling objective(s). Attempts should be made to utilize modern instructional technology (i.e. television, computers, videotapes, etc.) as much as possible in delivering the message desired. However, caution is advised in limiting the suggested resource section to only one alternative; due to the differing availability of resources between like programs across the state.

Provide Instruction

Many misconceptions exist about how an individual teacher must manage the instructional process when utilizing the competency based approach. Oftentimes CBE is considered synonmous with individualized instruction, wherein the instructor becomes the instructional manager of the educational process instead of the more traditional view of the teacher. Such misconceptions have led many educators to renounce competency based education as a means by which the teacher loses control and direction over the instructional process and is relegated to merely a role of record keeper.

The underlying concept of competency based instruction, however, does not dictate specific instructional procedures and methodologies, but rather assures that those skills, knowledges and attitudes deemed essential for job success are taught, mastered to acceptable standards and documented. How this instruction is managed within the classroom, be it on a large group, small group or individualized basis should be left up to the instructor.

The content of the task itself and the enabling objectives dictate what should be taught. Thus, the instructional activities and supporting resources identified in the instructional plan must be designed to accommodate learner mastery of the subject matter. Where appropriate, this instruction may involve large group activities, smaller group participation and/or solely individualized study.

Where substantial diversity exists between ability and skill levels of the learners within a class, arrangements should be made to structure learning activities that accommodate this difference. This type of instructional arrangement is particularly crucial, given that one of the major premises of competency based instruction is that the learner be allowed to progress at his/her own pace and that this progression be based upon successful mastery of sequential competencies.

Also, another major consideration that must be given to providing competency-based instruction is the development of a mechanism whereby learners, due to prior experience or instruction, be allowed to "test out" on skills already attained without undue duplication of effort. This situation is most often addressed through the use of pretests prior to formal instruction.

*Evaluate Learner Performance

Evaluation of learner performance is one of the most critical steps in the instructional process. Criterion-referenced evaluative measures are advocated over the traditional norm-referenced approach due to the importance of all learners being able to perform to specialized standards. As such, the evaluation of learning outcomes and their related tasks should include means of assessing learner mastery of the knowledges, attitudes, and skills outlined in the enabling objectives and regarded as essential for completion of the learning outcomes/tasks, and also, learner performance of the learning outcomes/tasks to the performance standard.

In order to adequately evaluate learners, consideration must be given to constructing testing situations that address any or all of the three domains of learning encompassed within the learning outcome or task (i.e., psychomotor, cognitive, and affective).

*Note: The Bureau of Vocational, Technical and Adult Education is currently in the process or has developed comprehensive test item banks (written and performance) for a number of vocational education areas of study. For information relative to the availability of these item banks, contact the Assistant Director, Curriculum and Personnel Development.

Guide Coding System

Example: 4.2.3

4. - unit designation
2. - learning outcome under unit
3 - task under learning outcome

VOCATIONAL EDUCATION CURRICULUM GUIDE

INDUSTRIAL EQUIPMENT MAINTENANCE

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Industrial Equipment Maintenance Standard Tool Kit

PROGRAM OF STUDY: Industrial and Technical Education

AREA OF STUDY: Industrial Equipment Maintenance

UNIT #1 Industrial Mechanics

LEARNING OUTCOME # 1.1 Prepare site for machine installation.

TASK # 1.1.1 Prepare site for machine installation.

PERFORMANCE STANDARD: Site for machine installation must be located and cleaned according to specifications. Mounting devices must be positioned and fastened according to manufacturer's specifications. Overhead clearance must be in accordance with manufacturer's specifications.

TOOLS, RESOURCES, EQUIPMENT AND SITUATION(S):

- Brooms, mops, etc.
- Chalk or paint
- Floor scraper
- Management's location drawing or specifications
- Manufacturer's machine specifications
- Personal safety equipment
- Recommended mounting devices
- Shovel
- Tape measure

PERFORMANCE GUIDE:

1. Locate designated area.
2. Shut down and disconnect all air, electric, water and hydraulic feed lines on equipment occupying designated area.
3. Remove any equipment occupying designated area.
4. Remove mounting and hold-down devices as necessary.
5. Clean designated area with shovel, floor scraper, broom, mop.
6. Mark position of incoming equipment on floor with chalk or paint.
7. Position any mounting devices of incoming equipment recommended by manufacturer.
8. Secure mounting devices as recommended by manufacturer of incoming equipment.
9. Check for overhead clearance equipment.

ENABLING OBJECTIVES:

1. Identify safety precautions when using cleaning compounds.
2. Explain reading manufacturer's specifications and drawings for mounting considerations.
3. Explain how to use a transit to determine the level- of the floor, and the positioning of mounting devices.
4. Describe the steps to be taken to determine if the structure is capable of supporting weight of equipment.
5. Identify the various mounting techniques and types of fasteners available.

LEARNING OUTCOME # 1.2 Raise machinery using jacks, bars, and crib blocks.

TASK # 1.2.1 Raise machinery using jacks, bars, and crib blocks.

PERFORMANCE STANDARD: Raised machinery must rest solidly on blocks at specified height in level, upright position.

TOOLS, RESOURCES, EQUIPMENT AND SITUATION(S):

Standard tool kit
Blocks
Jacks
Lifting bars
Personal safety equipment

PERFORMANCE STEPS:

1. Lock out machinery power and shut down all feed lines.
2. Disconnect all feed lines (air, water, electric, hydraulic) solidly connected to equipment to be raised.
3. Disconnect any mounting devices.
4. Position jacks at points which will balance machine when it is lifted.
5. Raise machine with lifting bars until jacks can be slid under machine.
6. Raise machine with jacks until sufficient clearance is obtained to insert blocks (2" x 2", 2" x 4", 4" x 4").

7. Lower jacks evenly until equipment is resting on blocks.
8. Remove jacks.

ENABLING OBJECTIVES:

1. Explain the relevant safety practices and procedures.
2. Identify the techniques for disconnecting hydraulic, pneumatic, and electrical connections.
3. Explain the lifting capacities of jacks.
4. Demonstrate how to safely operate a jack.
5. Define the terms: crib blocks, bars, jacks, and hoists.

LEARNING OUTCOME # 1.3 Move machinery.

TASK # 1.3.1 Move machinery.

PERFORMANCE STANDARD: Machinery must rest solidly on forks and be chained firmly to fork lift truck while being transported to designated area. Machinery must be transported with no damage to equipment or facility.

TOOLS, RESOURCES, EQUIPMENT AND SITUATION(S):

- Standard tool kit
- Blocks
- Chain
- Fork lift truck
- Jacks
- Lifting bars
- Manufacturer's specifications for fork lift truck
- Personal safety equipment

PERFORMANCE STEPS:

1. Lock out power and shut down equipment.
2. Disconnect all feed lines (air, water, electric, hydraulic) to equipment to be moved.
3. Estimate weight by using manufacturer's specifications.
4. Choose fork lift truck with sufficient lifting capacity.
5. Raise machine/equipment with lifting bars, blocks and/or jacks high enough to accommodate fork lift.
6. Move forks under machine, lift slightly and chain

machine (above center) to fork lift truck.
NOTE: Make sure chain or strap is not tied around any moving parts of fork lift.

7. Lift machinery.
8. Check for stability.
9. Transport to designated area.
10. Lower machinery into position on blocks.
11. Remove chain.
12. Remove fork lift.

ENABLING OBJECTIVES:

1. Explain the relevant safety practices and procedures.
2. Define lifting capacity of fork lift.
3. Describe the procedure for selecting the fork lift most appropriate for the task.
4. Locate in manufacturer's specifications weight of unit and lifting points.
5. Identify poor lifting points.

LEARNING OUTCOME # 1.4 — Remove and replace friction bearing and mechanical seals.

TASK(S) #
1.4.1 — Remove and replace friction bearing seals.
1.4.2 — Remove and replace mechanical seals.

TASK # 1.4.1 — Remove and replace friction bearing seals.

PERFORMANCE STANDARD: Bearing must operate at rated speed and load with no or slight visible leakage of lubricant for at least one hour. Machine must operate without excessive heat.

TOOLS, RESOURCES, EQUIPMENT AND SITUATION(S):

Standard tool kit
Cleaning rags
Personal safety equipment
Seal installation tools (driver, cone guide, and others approved by seal manufacturer)

PERFORMANCE STEPS:

1. Lock out machine power.
2. Determine path of leakage.
3. Clean surrounding surfaces.
4. Remove seal from seat.
5. Check seal for wear and damage.

6. Clean with solvent.
   NOTE: Allow to dry.
7. Inspect seal.
   NOTE: Inspect contact lip for excessive wear, off-center wear, cuts or gouges, or embedded foreign material, such as steel chips. Where applicable, spring that loads lip must be in correct position and undamaged.
8. Check shaft for wear and damage.
   NOTE: At point of seal contact, there should be no deep scratches or nicks.
   NOTE: Shaft should have specified machining finish originally.
   a. Check spline, keyway, or burred end that could have damaged lip on installation.
9. Examine bore for wear and damage.
   a. Check for nicks or gouges that could cause outside diameter leakage.
   b. Check for coarse machine leads, which could cause spiral leakage.
   c. Check for sharp, unrelieved corners at bore entrance that could cock and damage seal outside diameter.
10. Clean shaft.
   a. File or stone away burrs and bad nicks.
   b. Polish shaft with fine emery to expose smooth contact for seal lip.
   c. Smooth any sharp corners or edges at shaft and where seal first passes over it.
11. Clean bore area.
   a. Remove any nicks, gouges or entrance burrs with emery cloth.
12. Fill seal with oil or fluid according to manufacturer's specifications.
   a. Relieve pressure where necessary.
   b. Keep seal and fluid clean and free of shop dust or dirt.
13. Apply small amount of oil to seal lip to aid its passage over shaft.
14. Coat bore or seal outside diameter lightly with gasket cement.
   NOTE: If backed by a shoulder, do not allow sealing compound on shoulder side of seal which may cock it.
15. Press seal into bore with factory-approved driving tool, or driver made with old bearing outer ring slightly smaller than seal outside diameter.
   CAUTION: PROTECT SEAL BY COVERING THREADS, SPLINES, KEYWAYS OR OTHER SHARP EDGES AS NECESSARY.

16. Unlock/operate newly-installed seal for two or three hours to break it in.
17. Stop mechanism and check for heat and excessive leakage.

ENABLING OBJECTIVES:

1. Explain the relevant safety practices and procedures.
2. Differentiate between friction bearing seals and mechanical seals.
3. Identify the parts of a seal.
4. Explain how a friction bearing seal functions.
5. Describe what can damage a friction bearing seal.
6. List applications of friction bearing seals.

TASK # 1.4.2 Remove and replace mechanical seals.

PERFORMANCE STANDARD: Mechanism must operate smoothly, without leakage of fluid. Machine must operate without binding, squealing, leaks or excessive heat.

TOOLS, RESOURCES, EQUIPMENT AND SITUATION(S):

Standard tool kit
Manufacturer's manuals
Personal safety equipment
Scriber
Small drain pan

PERFORMANCE STEPS:

1. Lock out equipment power.
2. Shut off all fluid lines to equipment.
3. Remove coupling from machine mechanism.
   NOTE: Catch fluid in pan if necessary.
4. Disassemble machine mechanism to expose seal area.
5. Scribe mark location of old mechanical seal on shaft.
6. Remove old mechanical seal.
7. Inspect housing, bearings, and shaft for wear or damage.
8. Install rotating portion of seal on shaft.
9. Check for parallelism of faces.
   CAUTION: DO NOT COCK SEAL ON SHAFT - TIGHTEN DOWN EVENLY. DO NOT TOUCH SEAL FACES WITH FINGERS.
10. Install stationary seal component in end cover.
11. Install end cover on mechanism and bolt together.
12. Install coupling.
13. Turn on all fluid lines.
14. Unlock/turn on machine and test for freedom of operation.

ENABLING OBJECTIVES:

1. Explain the relevant safety practices and procedures.
2. Identify the parts of the mechanical seals.
3. Explain how mechanical seals functions.
4. Describe what can damage a mechanical seal.
5. List applications of mechanical seals.

LEARNING OUTCOME # 1.5 Select and apply industrial lubricants.

TASK # 1.5.1 Select and apply industrial lubricants.

PERFORMANCE STANDARD: Lubricant selected must comply with manufacturer's specifications. Lubricant must be applied as specified by manufacturer.

TOOLS, RESOURCES, EQUIPMENT AND SITUATION(S):

Standard tool kit
Grease gun
Lubricants
Manufacturer's specifications
Oil can

PERFORMANCE STEPS:

1. Determine type of material to be lubricated.
2. Determine operating conditions present.
3. Check manufacturer's specifications for special conditions and considerations.
4. Select lubricant.
5. Clean fittings.
6. Apply lubricant with oil can or grease gun.
7. Wipe fitting clean.

ENABLING OBJECTIVES:

1. Differentiate between oil, grease and synthetic lubricants.
2. Explain contamination of lubricants.
3. Describe the refining processes.
4. Explain rating and classification codes.
5. Identify environmental consideration for waste disposal.
6. List possible handling and storage problems.
7. List various applications for each type of lubricant.

LEARNING OUTCOME # 1.6 Install and align pillow block bearings.

TASK # 1.6.1 Install and align pillow block bearings.

PERFORMANCE STANDARD: Bearings must rotate freely, and bearings and shaft must be within one degree of alignment. Machine must operate without scratching, squealing, grating or other unusual noises. Machine must operate without excessive heat.

TOOLS, RESOURCES, EQUIPMENT AND SITUATION(S):

Standard tool kit	Level
Dial indicator	Personal safety equipment
Equipment manuals	Shim stock
Grease gun	Straightedge

PERFORMANCE STEPS:

1. Lock out machine power.
2. Inspect base area for damage and debris.
3. Assure shaft is free of nicks, burrs, and damage or wear.
4. Try bearing on shaft for fit.
5. Lubricate lightly.
   NOTE: Remove if necessary.
6. Bolt pillow blocks in place.
7. Check bearing for alignment by using dial indicator, level, straightedge, and feeler gauges.
8. Loosen and tighten bolts as necessary.
9. Shim as needed.
10. Turn bearings freely by hand.
11. Lubricate bearing according to specifications.
12. Unlock/turn on machine.
13. Test for freedom of rotation and operation.

ENABLING OBJECTIVES:

1. Explain the relevant safety practices and procedures.
2. Define a pillow block bearing.
3. List applications of pillow block bearings.
4. Explain how to set up and read a dial indicator.
5. Identify the cause of bearing failure.
6. Define the type of lubricants that can and cannot be used with pillow block bearings.

LEARNING OUTCOME # 1.7 Remove and replace bearings and sleeve bearing in bores.

TASK(S) # 1.7.1 Remove and replace bearings in bores.
1.7.2 Remove and replace sleeve bearing in bores.

TASK # 1.7.1 Remove and replace bearings in bores.

PERFORMANCE STANDARD: Bearings must rotate smoothly and freely, and be within 1/2 degree of true alignment. Machine must operate without grating, squealing, scratching, or other unusual noises. Machine must operate without excessive heat.

TOOLS, RESOURCES, EQUIPMENT AND SITUATION(S):

- Standard tool kit
- Bearing pullers
- Dial indicator
- Manufacturer's manuals
- Personal safety equipment
- Press or hydraulic ram
- Replacement bearings (ball, roller, pin, taper)
- Shim stock

PERFORMANCE STEPS:

1. Lock out machine power.
2. Dismantle mechanism to expose bearings.
3. Inspect bearings for wear and damage.
4. Remove old bearing.
   a. Ball bearing.
   b. Roller bearing.
   c. Pin bearing.
   d. Taper bearing.
5. Inspect shaft and housing for damage, wear and evidence of bearing slippage.
6. Check parts manual of machine for bearing required.
7. Obtain replacement bearing(s).
8. Check new bearing(s) for roundness, diameters and fit with micrometers.
9. Build up or turn down shaft as necessary.
10. Rebore housing if necessary to install larger bearing.
11. Install replacement bearing(s).
12. Lubricate according to manufacturer's specifications.
13. Check bearing for smooth rotation.
    NOTE: Taper bearings may have to be shrunk on shaft.
14. Measure true position of bearing with dial indicator.
15. Unlock/turn on machine and test for freedom of operation.

ENABLING OBJECTIVES:

1. Explain the relevant safety practices and procedures.
2. List four different styles of bearing, their applications and their advantages.
3. Identify the parts of a bearing.
4. Explain how to set up and read a dial indicator.
5. Explain how to use and read a micrometer.
6. Describe how to shrink the bearing on shaft.
7. Explain and demonstrate rebore procedures.
8. Identify causes of bearing failure.
9. Distinguish between damage and undamaged bearing.
10. Explain how to set up and use an hydraulic ram for removal and placement of bearings.

TASK # 1.7.2 Remove and replace sleeve bearing in bores.

PERFORMANCE STANDARD: Replacement bearing must be free of burrs or distortion and must operate freely. Machine must operate without binding, grating, squealing, scratching, or excesive heat.

TOOLS, RESOURCES, EQUIPMENT AND SITUATION(S):

Standard tool kit
Mandrels
Manufacturer's specifications
Micrometer
Personal safety equipment
Press
Telescope gauges

PERFORMANCE STEPS:

1. Lock out machine power.
2. Loosen bolts in bearing block.
3. Raise shaft slightly.
4. Remove bearing block.
5. Remove sleeve bearing from block using hammer and mandrel or press.
6. Check size with telescope gauge and micrometer.
7. Clean bore and inspect for damage, cracks and scratches.
8. Obtain replacement bearing.
9. Check for burrs.
10. Check for proper fit in bore.
11. Press or drive in replacement bearing.
12. Align lubrication holes as necessary.
13. Check bearing for distortion with telescope gauges or micrometer.
    a. Replace, rebore if necessary.
14. Check bearing for proper seating in bore.
    a. Replace, rebore if necessary.
15. Place prussian blue on shaft.

16. Slide new bearing on shaft.
17. Lower shaft.
18. Rotate shaft.
19. Remove bearing from shaft.
20. Scrape/clean shaft.
21. Check for burrs.
22. Clean bearing.
23. Lube shaft and bearing.
24. Reassemble.
25. Unlock/turn on machine and test for freedom of operation.

ENABLING OBJECTIVES:

1. Explain the relevant safety practices and procedures.
2. Identify the characteristics and applications of a sleeve bearing.
3. Explain how to set up and read telescope gauges.
4. Explain how to set up and read micrometers.
5. Describe how to set up and use mandrel and press for removal and replacement of sleeve bearings.
6. Identify damaged sleeve bearing and probable causes for damage.
7. Explain the effects on sleeve bearings.
8. Identify the types of lubricants to be used with sleeve bearings.
9. Define the terms shimming and seating a bearing.
10. Define the term lubrication hole and explain its importance when installing bearings.

LEARNING OUTCOME #	1.8	Straighten shaft using press,install bearings, replace, and align shaft.
TASK(S) #	1.8.1	Straighten shaft using press.
	1.8.2	Remove and install bearings on shaft.
	1.8.3	Replace and align shaft.
TASK #	1.8.1	Straighten shaft using press.
PERFORMANCE STANDARD:		Shaft must be straight within.002 inch accuracy, and when rotated or rolled on flat surface, must show no indication of being bent.

TOOLS, RESOURCES, EQUIPMENT AND SITUATION(S):

Standard tool kit	Personal safety equipment
Arbor press	Support blocks
Dial indicator	Surface plate
Lathe with headstock/ tailstock centers	

PERFORMANCE STEPS:

1. Determine length and diameter of shaft.
2. Obtain support blocks.
   NOTE: Assure protection of shaft from flat spots when straightening.
3. Locate and mark high spot on shaft.
4. Place center of high point of bent shaft in press.
5. Apply pressure on shaft sufficient to straighten it by operating press.
6. Check amount of spring back.
7. Remove shaft.
8. Roll shaft on surface plate or other known flat surface.
9. Check for straightness with scale.
   a. Re-straighten as necessary.
10. Check spring back.
11. Mount in lathe between centers.
12. Rotate slowly and measure runout with dial indicator.
13. Repeat steps 3-11 until shaft is straight to specifications.

ENABLING OBJECTIVES:

1. Explain the relevant safety practices and procedures.
2. Describe the set up of an arbor press.
3. Demonstrate mounting shaft between center of lathe and setting up dial indicator on lathe.
4. Define the terms, run out, spring back, high point, and flat spotting.
5. Explain the effects of using heat on shaft if used for straightening purposes.
6. Differentiate between a normal shaft and a hardened shaft.
7. Explain testing and inspecting procedures for hairline cracks in shafts.
8. Describe magna fluxing and sonar devices for examining shaft damage.

TASK # 1.8.2 Remove and install bearings on shaft.

PERFORMANCE STANDARD: Bearings and shaft must rotate freely and be within one degree of alignment. Machine must operate without binding, grating, scratching or excessive heat.

TOOLS, RESOURCES, EQUIPMENT AND SITUATION(S):

- Standard tool kit
- Bearing presses
- Bearing pullers
- Grease gun
- Mandrels
- Manufacturers' manuals
- Micrometer
- Personal safety equipment
- Rags
- Replacement bearing (ball, roller, pin, taper)
- Telescope gauges

PERFORMANCE STEPS:

1. Lock out machine power.
2. Remove old bearings.
3. Inspect shafts for damage, nicks, burrs or wear.
4. Check shaft outside diameter.
5. Check bearing inside diameter.
6. Check parts manual of machine for bearing required.
7. Select replacement bearing(s).
8. Check bearings and shafts for correct fit with micrometer.
9. Install bearing on shaft using hydraulic ram or presses.
10. Check for proper seating on shaft.
11. Check bearing for distortion and freedom of rotation.
12. Lubricate bearing.
13. Unlock/turn on machine and test for freedom of rotation.

ENABLING OBJECTIVES:

1. Explain the relevant safety practices and procedures.
2. Identify four types of bearings and their characteristics and applications.
3. Describe how to use and read micrometer.
4. Identify the parts of a bearing.
5. Describe the effects of heat on bearings.
6. List the causes of bearing failure.
7. Identify the various types of lubricants and techniques for lubricating the bearing.

TASK # 1.8.3 Replace and align shaft.

PERFORMANCE STANDARD: Shaft and bearings must operate smoothly and freely and must be within one degree of alignment. Machine must operate without scratching, squealing or excessive heat.

TOOLS, RESOURCES, EQUIPMENT AND SITUATION(S):

Standard tool kit
Level
Lifting devices
(for large shafts)
Oil can
Personal safety equipment
Rags
Wire

PERFORMANCE STEPS:

1. Lock out machine power.
2. Dismantle mechanism to expose shaft.
3. Inspect shaft for damage.
4. Remove any burrs or nicks.
5. Remove collars, bearing or other components from shaft.
   a. Check/replace as necessary.
6. Remove shaft.
7. Select replacement shaft.
8. Check for proper fit in bores and housings with micrometers.
9. Lubricate shaft.
10. Install shaft.
11. Check for alignment with dial indicators, wire, level, straightedge, and feeler gauges.
12. Check for runout and end play with dial indicator.
13. Lubricate bearings.
14. Inspect shaft for freedom of movement in bearings.
15. Unlock/turn on machine and test for freedom of operation.

ENABLING OBJECTIVES:

1. Explain the relevant safety practices and procedures.
2. Demonstrate how to use a micrometer, a dial indicator, feeler gauges, and levels.
3. Define the terms run out and end play.
4. Describe the effects of an improperly aligned shaft.
5. Identify shaft damage, bearing damage, seal damage, their cause, and the correction procedure for each.

LEARNING OUTCOME # 1.9 Adjust gibs for free operation.

TASK # 1.9.1 Adjust gibs for free operation.

PERFORMANCE STANDARD: All moving parts must operate freely without binding or side movement and must be within specified clearance.

TOOLS, RESOURCES, EQUIPMENT AND SITUATION(S):

- Standard tool kit
- Dial indicator
- Feeler gauges
- Gib wrenches or slotted screwdriver head
- Oil can
- Personal safety equipment
- Scrapers
- Shim stock (assortment of metal shims)
- Wiping rags

PERFORMANCE STEPS:

1. Remove gibs.
2. Wipe/clean gib area(s).
3. Determine gib clearance on both sides and ends with feeler gauges.
4. Check sliding surfaces of mechanism for excessive wear with dial indicator and micrometers.
5. Check gib surfaces for excessive wear and galled with dial indicator.
   a. Replace, straighten, or scrape if necessary.
6. Adjust gib by loosening screw at small end and tightening screw at large end of gib.
7. Draw up to point of feeling pressure and back off to specified clearance.
8. Lubricate.
9. Operate mechanism for freedom of operation.

ENABLING OBJECTIVES:

1. Explain the relevant safety practices and procedures.
2. Describe the function on a gib and give examples of its application.
3. Describe excessive wear and galled in relationship to gibs.
4. Explain set up and reading dial indicators, micrometers for checking a gib and sliding surfaces of the mechanism.

LEARNING OUTCOME # 1.10 Fabricate and install safety guards for conveyor system.

TASK # 1.10.1 Fabricate and install safety guards for conveyor system.

PERFORMANCE STANDARD: Guard must be of specified material and design. Guard must fit on conveyor system.

TOOLS, RESOURCES, EQUIPMENT AND SITUATION(S):

- Standard tool kit
- Metal or plastic cutting and bending tools
- OSHA Regulations Manual
- Personal safety equipment
- Square

PERFORMANCE STEPS:

1. Lock out conveyor power source.
2. Obtain copy of current OSHA regulations for conveyor systems.
3. Inspect area of conveyor to be guarded.
4. Determine clearance for conveyor.
   NOTE: Consult OSHA specifications.
5. Measure and determine fastening points for guard.
6. Make sketch and/or blueprint with appropriate measurements included.
7. Select material for guards/brackets.
8. Cut guard/bracket material to size.
9. Form guards/brackets to fit guarded areas.
10. Try guards/brackets on conveyor for fit.
11. Drill holes.
12. Install safety guard.
13. Unlock/start.
14. Check for binding/interference of safety guard.
15. Stop conveyor.

ENABLING OBJECTIVES:

1. Explain the relevant safety practices and procedures.
2. Explain the relevant sections of OSHA regulations.
3. Interpret the blueprints to locate fastening points and clearance requirements.
4. Illustrate with measurements the desired safety guards to be fabricated and installed.
5. Identify and describe the material to be used in the fabrication.
6. Explain the fabrication procedure.
7. Analyze the conveyor system as to how it functions and what guards are required.

8. Analyze how to best install the guards at to protect the operator and not interfere with the operation of the conveyor.

LEARNING OUTCOME # 1.11 Assemble conveyor and align drive mechanism for material handling system.

TASK # 1.11.1 Assemble conveyor and align drive mechanism for material handling system.

PERFORMANCE STANDARD: Conveyor system must operate freely without binding, vibrations, and interference according to manufacturer's specifications.

TOOLS, RESOURCES, EQUIPMENT AND SITUATION(S):

Standard tool kit	Oil can
Conveyor manuals and specifications	Personal safety equipment
	Wiping rags

PERFORMANCE STEPS:

1. Lay out all parts for assembly.
2. Check component parts for completeness, damage,
   a. Replace/repair parts as necessary.
3. Lubricate parts according to manufacturer's specifications.
4. Determine sequence of assembly.
5. Assemble/install parts loosely in sequence.
6. Check fit of all parts during assembly.
7. Install and align pulleys and belt support devices.
8. Install belts, buckets or conveyor devices.
9. Remove slack and tighten belts and chains.
10. Check all parts for binding and freedom of movement.
11. Align belts and buckets according to manufacturer's manuals and specification sheets.
12. Lubricate assembled conveyor system in accordance with manufacturer's specifications.
13. Turn on/operate system.
14. Check for freedom of operation without binding, rubbing and interference.

ENABLING OBJECTIVES:

1. Explain the relevant safety practices and procedures.
2. Explain how the conveyor is to function.
3. Identify different types of conveyor or systems.
4. List examples of conveyors systems; where they are used and why.
5. Explain shimming techniques.
6. Explain alignment alternatives.
7. Locate in manufacturer's specifications and explain alignment data, capacity limitations, and assembly procedures.

UNIT # 2 Hydraulic/Pneumatic System

LEARNING OUTCOME # 2.1 Read and interpret hydraulic/pneumatic diagrams.

TASK # 2.1.1 Read and interpret hydraulic/pneumatic diagrams.

PERFORMANCE STANDARD: Specified components and connections must be identified. Required component specifications must be listed and must be in accordance with hydraulic/pneumatic diagrams.

TOOLS, RESOURCES, EQUIPMENT AND SITUATION(S):

Hydraulic/pneumatic diagram

PERFORMANCE STEPS:

1. Identify hydraulic/pneumatic symbols on diagram.
2. List components from diagram specifications.
3. Identify component connections.
4. Trace fluid/air flow through components parts.

ENABLING OBJECTIVES:

1. Identify components of hydraulic/pneumatic systems.
2. Describe the function of component parts of hydraulic and pneumatic systems.

LEARNING OUTCOME # 2.2 Replace or clean hydraulic filters, and refill hydraulic system.

TASK # 2.2.1 Replace or clean hydraulic filters, and refill hydraulic system.

PERFORMANCE STANDARD: Strainer and filter must be clean and system must operate at specified fluid levels without leaks around strainer/filter.

TOOLS, RESOURCES, EQUIPMENT AND SITUATION(S):

Standard tool kit
Drain pan
Personal safety equipment

PERFORMANCE STEPS:

1. Lock out equipment power
2. Place drain pan under strainer/filter.
3. Drain strainer/filter.
4. Remove strainer/filter and seals if any.
5. Clean strainer and seals if any.
6. Replace filter and seals if any.
7. Re-install strainer/filter.
8. Check fluid levels.
   a. Replenish as necessary.
9. Unlock and start equipment.
10. Inspect for leaks.
11. Turn off equipment.

ENABLING OBJECTIVES:

1. Explain the relevant safety practices and procedures.
2. Describe techniques for draining hydraulic systems.
3. Differentiate between filter, screens, and strainers.
4. Describe the function of filters, screens, and strainers.
5. Visually identify hydraulic filters, screens, and strainers.
6. Identify various types of hydraulic fluids and their applications.

LEARNING OUTCOME # 2.3 Align piston rod of hydraulic cylinder and adjust hydraulic pressure.

TASK(S): 2.3.1 Align piston rod of hydraulic cylinder.
2.3.2 Align hydraulic pressure.

TASK # 2.3.1 Align piston rod of hydraulic cylinder.

PERFORMANCE STANDARD: Rod must indicate zero when measured by dial indicator.

TOOLS, RESOURCES, EQUIPMENT AND SITUATION(S):

Standard tool kit
Dial indicator
Manufacturer's specifications
Personal safety equipment
Shim material

PERFORMANCE STEPS:

1. Position dial indicators to ride on rod while it moves in and out.
2. Cycle machine.
3. Measure side loads.
   a. Loosen mounting bolts.
   b. Shift cylinder until dial indicators measure zero.
      (1) Shim as necessary.
   c. Tighten mounting bolts.
4. Recycle machine and check indicators for deflection within manufacturer's specifications.

ENABLING OBJECTIVES:

1. Explain the relevant safety practices and procedures.
2. Identify parts of a hydraulic cylinder.
3. Describe how a hydraulic unit functions.
4. Identify the components of the hydraulic unit.
5. Explain set up and reading dial indicator.
6. Explain how to determine side loads.
7. Describe the function of a shim.
8. List materials that can be used for shimming.

TASK # 2.3.2 Adjust hydraulic pressure.

PERFORMANCE STANDARD: Pressure must be indicated on pressure gauge with system operating according to manufacturer's specifications.

TOOLS, RESOURCES, EQUIPMENT AND SITUATION(S):

Standard tool kit
Manufacturer's specifications
Personal safety equipment

PERFORMANCE STEPS:

1. Start system.

2. Read and record present value on pressure gauge.
3. Unlock pressure control valve stem if so equipped.
4. Adjust pressure to specified reading on pressure gauge by turning pressure control valve stem.
5. Lock valve stem if so equipped.
6. Stop equipment.

ENABLING OBJECTIVES:

1. Explain the relevant safety practices and procedures.
2. Differentiate between no load operation and load operation.
3. Identify the components of the hydraulic system.
4. Identify the parts of the pressure regulator.
5. Describe how the pressure regulator functions.
6. Explain how to read pressure gauge.
7. Explain how to test pressure gauges.
8. Describe how the pressure gauge functions.
9. Describe the different types of pressure gauges.

LEARNING OUTCOME # 2.4 Replace and align hydraulic motor/pump.

TASK(S) # 2.4.1 Replace hydraulic motor/pump.
2.4.2 Align hydraulic motor/pump.

TASK # 2.4.1 Replace hydraulic motor/pump.

PERFORMANCE STANDARD: Motor/pump must operate to manufacturer's specifications at specified pressure and flow with no leaks.

TOOLS, RESOURCES, EQUIPMENT AND SITUATION(S):

Standard tool kit
Manufacturer's specifications
Personal safety equipment
Scraper
Wire brush

PERFORMANCE STEPS:

1. Lock out system power.
2. Reduce pressure in system.
3. Clean disconnect areas.
4. Remove motor/pump coupling.
5. Disconnect hydraulic lines.
6. Remove mounting bolts.
7. Remove motor/pump,
8. Remove old fittings.
9. Install new motor/pump.
10. Clean mounting surface.
11. Install seals as required.
12. Mount motor/pump to its base.

13. Install mounting bolts loosely.
14. Align motor/pump.
15. Connect coupling(s).
16. Tighten mounting bolts.
17. Reconnect hydraulic lines.
    a. Oil seals as necessary.
18. Replace lost fluid.
19. Unlock/start system, operate at specified pressure and flow.
20. Check for leaks.
21. Shut off system.

ENABLING OBJECTIVES:

1. Explain the relevant safety practices and procedures.
2. Describe how a hydraulic pump functions.
3. Describe the different types of hydraulic pumps.
4. Identify part of hydraulic pump.
5. Explain how to remove and install seals and bearings.
6. Demonstrate how to align motor and pump.
7. Identify coupling techniques.
8. Compare old unit specifications to specifications for new unit.
9. Identify bolt grades.

TASK # 2.4.2 Align hydraulic motor/pump.

PERFORMANCE STANDARD: Motor/pump must be within one degree of alignment and must operate with no leaks or vibration.

TOOLS, RESOURCES, EQUIPMENT AND SITUATION(S):

Standard tool kit	Shim material
Dial indicator	Straightedge
Personal safety equipment	

PERFORMANCE STEPS:

1. Lock out equipment power.
2. Loosen mounting bolts.
3. Loosen pipe line/mounts.
4. Loosen drive coupling.
5. Check for damage.
6. Align pump and pipe lines.
   a. Use straightedge or piano wire and level.
   b. Shim as necessary.
   c. Retighten mounting bolts of pump.
7. Align motor coupling to pump vertically by using:

Straightedge and feelers.
a. Shift until faces are parallel.
b. Shim.

Dial indicator.
a. Attach to driver coupling half with tip in contact with driven coupling half.
b. Rotate both shafts together.
c. Shim equal to 1/2 total indicator runout.

8. Align motor coupling to pump horizontally by using:

Straightedge and feelers.
a. Shift until faces are parallel.
b. Shim.

Dial indicator.
a. Attach to face of driver shaft coupling half with tip on face near rim of driven shaft.
b. Rotate driver and shift until zero runout.
c. Set tip on outside surface of driven half.
d. Rotate driver.
e. Move driver transversely (perpendicular to line) until zero runout.
f. Shim as necessary.

9. Insert element between coupling halves.
10. Fasten coupling halves.
11. Bolt motor (driver) in position.
12. Fasten pipe mounts.
13. Unlock power.
14. Check for vibration, binding, and leaks.

ENABLING OBJECTIVES:

1. Explain the relevant safety practices and procedures.
2. Explain setting up and reading a dial indicator.
3. Differentiate between vertical and horizontal pumps.
4. Explain drive couplings.
5. Describe function of shim.
6. Identify materials that can be used for shimming.

LEARNING OUTCOME # 2.5 Install hydraulic lines, replacing all gaskets, seals, and damaged fittings.

TASK # 2.5.1 Install hydraulic lines, replacing all gaskets,seals and damaged fittings.

PERFORMANCE STANDARD System must operate according to manufacturer's specifications with no leaks.

TOOLS, RESOURCES, EQUIPMENT AND SITUATION(S):

Standard tool kit	Personal safety equipment
Drain pan	Scraper
Manufacturer's specifications	Wire brush

PERFORMANCE STEPS:

1. Lock out system power.
2. Reduce pressure in system.
3. Determine type of lines/fittings/components.
   a. Pipe.
   b. Tubing.
   c. Hoses.
4. Determine damaged/faulty fittings/components.
5. Clean disconnect areas.
6. Position drain pans if needed.
7. Disconnect any hydraulic lines.
8. Remove damaged/faulty fittings/components.
9. Inspect for damage or wear.
10. Clean connecting areas.
11. Select replacement lines/fittings/components.
    a. Pipe.
    b. Tubing.
    c. Hoses.
12. Install gaskets/seals.
13. Align and connect drive/driven couplings.
14. Install replacement lines/fittings/components.
15. Reconnect any hydraulic lines.
16. Add hydraulic fluid to specified level.
17. Unlock/start system and check for leaks.
18. Turn off system.

ENABLING OBJECTIVES:

1. Explain the relevant safety practices and procedures.
2. Visually identify types of lines and fitting.
3. Identify damaged lines and fittings.
4. Explain torquing to specifications.
5. Identify gaskets and seals.
6. Explain replacing seals.
7. List causes of line and fitting damage.
8. Identify types of hydraulic fluid and their applications.

LEARNING OUTCOME # 2.6 Measure pressure using incline tester, inspect pressure relief valve, and replace if necessary.

TASK(S) # 2.6.1 Measure pressure using inline tester.
2.6.2 Inspect pressure relief valve and replace.

TASK # 2.6.1 Measure pressure using inline tester.

PERFORMANCE STANDARD: Pressure reading will be obtained from the pressure gauge, and the system will operate according to manufacturer's specifications without leaks.

TOOLS, RESOURCES, EQUIPMENT AND SITUATION(S):

Standard tool kit
Manufacturer's specifications
Personal safety equipment
Pressure gauge (calibrated)

PERFORMANCE STEPS:

1. Determine point at which pressure reading is to be taken.
2. Reduce pressure.
3. Lock out system power.
4. Install pressure gauge.
5. Unlock/start system and check for leaks.
6. Read pressure gauge.
7. Turn off system/reduce pressure.
8. Remove pressure gauge.
9. Start system and check for operation and leaks.
10. Turn off system.

ENABLING OBJECTIVES:

1. Explain the relevant safety practices and procedures.
2. Illustrate fluid flow through the hydraulic unit.
3. Identify from the manufacturer's specifications the desire pressure reading and the location in which to install inline tester.
4. Explain how inline pressure gauges operate.

TASK # 2.6.2 Inspect pressure relief valve and replace if necessary.

PERFORMANCE STANDARD: Valve must relieve pressure on system at any point within the manufacturer's specified pounds per square inch (PSI) limits with no leaks.

TOOLS, RESOURCES, EQUIPMENT AND SITUATION(S):

Standard tool kit
Drain pan
Personal safety equipment
Wiping rags

PERFORMANCE STEPS:

1. Lock out system power.
2. Reduce pressure.
3. Clean disconnect area.
4. Place drain pan.
5. Remove valve by disconnecting piping.
6. Unscrew lock nut on adjusting screw as necessary.
7. Remove pressure from adjusting screw threads by turning adjusting screw.
8. Remove cover.
9. Inspect "O" ring, spring, valve piston and valve body for damage and wear.
   a. Replace if necessary.
10. Reassemble valve.
11. Connect valve into system.
    a. Oil seals as necessary.
12. Add hydraulic fluid to specific level.
13. Unlock/start system and check for leaks.
14. Adjust/vary pressures to manufacturer's specifications.
15. Adjust to specified pressure.
16. Lock adjusting screw if exists.
17. Shut off system.

ENABLING OBJECTIVES:

1. Explain the relevant safety practices and procedures.
2. Visually identify types of lines and connectors used on hydraulic units.
3. Describe how a pressure relief valve operates.
4. Identify the internal parts of a pressure relief valve.
5. Visually identify damaged parts of pressure relief valve.

LEARNING OUTCOME # 2.7 Lubricate air compressor.

TASK # 2.7.1 Lubricate air compressor.

PERFORMANCE STANDARD: All lubricating points and fittings must be lubricated using manufacturer's specified lubricant grades and be reassembled to specifications.

TOOLS, RESOURCES, EQUIPMENT AND SITUATION(S):

Standard tool kit
Grease gun
Oil can
Personal safety equipment
Wiping rags

PERFORMANCE STEPS:

1. Lock out system power.
2. Drain water/liquid from air tank.
3. Disassemble machinery/equipment to expose lubricating points as necessary.
4. Inspect for defective or worn parts.
   a. Repair or report as necessary.
5. Clean oiling points.
6. Add oil according to manufacturer's specifications.
7. Clean lubrication fittings.
8. Lubricate according to manufacturer's specifications.
9. Reassemble machinery/equipment.
10. Unlock/start power unit to build up specified pressure as necessary.
11. Check operation in accordance with manufacturer's specifications.
12. Turn off equipment.

ENABLING OBJECTIVES:

1. Explain the relevant safety practices and procedures.
2. Identify the components of an air compressor.
3. Describe how an air compressor operates.
4. Explain why air compressors accumulate water.
5. Explain compressor ratings in terms of pressure and volume capabilities.
6. Describe various types of air compressors and their applications.
7. Identify from manufacturer's specifications the type and amount of lubricant to be used.

LEARNING OUTCOME # 2.8 Install fan guards, shrouds or mesh covers, and air filters.

TASK # 2.8.1 Install fan guards, shrouds or mesh covers, and air filters.

PERFORMANCE STANDARD: Fan guards, shrouds or mesh covers and air filters must have been cleaned, installed or replaced according to manufacturer's specifications.

TOOLS, RESOURCES, EQUIPMENT AND SITUATION(S):

- Standard tool kit
- Compressed air/steam
- Grease gun
- Manufacturer's specifications
- Oil can
- Open ended wrenches
- Personal safety equipment
- Pliers
- Screwdrivers
- Steel brush
- Wiping rags

PERFORMANCE STEPS:

1. Lock out system power.
2. Remove old fan guard, shroud or mesh cover, or air filter.
3. Clean and examine for damage, corrosion or wear.
   a. Replace if necessary.
4. Clean and adjust fan blades,housing and ducts as necessary.
5. Lubricate fan as necessary.
6. Install filter according to manufacturer's specifications.
7. Position guard, shroud or cover on fan housing.
8. Fasten to housing.
9. Unlock/test for noise/vibration/operation in accordance with manufacturer's specifications.
10. Turn off system.

ENABLING OBJECTIVES:

1. Explain the relevant safety practices and procedures.
2. Explain the relevant section of OSHA code for guards.
3. Describe the function of an air filter.
4. Locate from manufacturer's specifications clearance and attachment techniques.

LEARNING OUTCOME # 2.9 Install piping, tubing, and fittings.

TASK(S) # 2.9.1 Install piping and fittings.
2.9.2 Install tubing and fittings.

TASK # 2.9.1 Install piping and fittings.

PERFORMANCE STANDARD: Pipes and fittings must not leak or sag and must be in compliance with design drawings, codes, and regulations.

TOOLS, RESOURCES, EQUIPMENT AND SITUATION():

- Standard tool kit
- Cutoff saws
- Local codes and regulations
- OSHA Regulations
- Personal safety equipment
- Pipe charts and tables
- Pipe threading equipment
- Pipe wrenches
- Scriber
- Welding equipment
- Wiping rags

PERFORMANCE STEPS:

1. Lock out system power.
2. Shut off valves.
3. Select pipe and fittings as per code/regulations.
4. Measure pipe.
5. Cut pipe.
6. Prepare ends of pipe.

   Threaded:
   a. Thread pipe ends according to specifications.

   Flanged:
   a. Apply sealants.
   b. Tighten collars and bolts.
   CAUTION: USE SPECIFIED TORQUE RATINGS.
7. Support pipe/fittings with hangers.
8. Unlock power.
9. Pressurize line(s).
   a. Check for leaks.
10. Color code or mark line(s) per OSHA regulations.

ENABLING OBJECTIVES:

1. Explain the relevant safety practices and procedures.
2. Explain the relevant sections of OSHA regulations.
3. Explain codes and regulations other than OSHA.
4. Identify different types of pipe, pipe fittings, and their applications and limitations.
5. Differentiate between pipe threads and high pressure threads.
6. Differentiate between valves used for liquids and gases or air.
7. Demonstrate cutting threads.
8. Identify pipe unions and their application.

TASK # 2.9.2 Install tubing and fittings.

PERFORMANCE STANDARD: Tubing and fittings must not leak or interfere with other pipes.

TOOLS, RESOURCES, EQUIPMENT AND SITUATION(S):

- Standard tool kit
- Cutoff tools for tubing
- Flaring tool for tubing
- OSHA regulations
- Personal safety equipment
- Tubing bender

PERFORMANCE STEPS:

1. Inspect existing tubing and fittings for damage or leaks.
2. Measure distances to route tubing.
3. Select tubing/fittings.
4. Cut tubing.
5. Flare tubing on flaring tool.
6. Bend to fit, using tubing bender.
7. Support tubing with hangers.
8. Install fittings.
9. Connect tubing lines to system.
10. Unlock power
11. Pressurize system, bleed if necessary.
12. Check for leaks.

ENABLING OBJECTIVES:

1. Explain the relevant safety practices and procedures.
2. Explain the relevant sections of OSHA regulations.
3. Explain the codes and regulations other than OSHA that might be encountered.
4. Identify different types of tubing and their applications and limitations.
5. Identify different types of fittings available for tubing and their applications and limitations.
6. Differentiate between tubing for low pressure and high pressure applications.
7. Define bleeding a system.
8. Demonstrate flaring tubing.
9. Explain torquing fittings.

UNIT #3 Crane Elevator

LEARNING OUTCOME # 3.1 Replace and service batteries.

TASK # 3.1.1 Replace and service batteries.

PERFORMANCE STANDARD: Battery must be replaced with terminals connected and coated according to manufacturer's specifications.

TOOLS, RESOURCES, EQUIPMENT AND SITUATION(S):

- Standard tool kit
- Acid proof paint
- Baking soda
- End wrenches
- Lift strap
- Manufacturer's specifications
- Non-metallic grease
- Protective pad
- Putter
- Steel brush
- Terminal cleaning brush
- Terminal puller
- Terminal spreader
- Water

PERFORMANCE STEPS:

1. Cover fender with protective pad.
2. Note which battery post is grounded (usually negative).
3. Loosen both terminal clamps.
4. Disconnect ground cable terminal.
   a. Use puller if necessary.
5. Disconnect positive terminal.
   a. Use puller if necessary.
6. Remove hold-down plate or bar.
7. Attach battery lift strap.
8. Lift out old batter.
   CAUTION: DO NOT SPILL ELECTROLYTE.
9. Inspect battery cage or holder and hold-down device for damage and corrosion.
10. Clean with steel brush and baking soda and water.
11. Paint with acid-proof paint.
12. Clean cable terminals with steel brush and soda/water solution.
13. Clean terminals of replacement battery.
14. Attach battery lift strap to replacement battery.
15. Place new battery into holder.
    NOTE: Battery terminals should be in position to receive cables.
16. Install hold-down plate.
17. Connect positive terminal.
18. Connect ground terminal.
19. Coat terminals and posts with non-metallic grease.

ENABLING OBJECTIVES:

1. Explain the relevant safety practices and procedures.
2. Describe chemical change which occurs during charging and discharging.
3. Explain how to use and read a battery hydrometer.
4. Explain how current flows through a battery.
5. Describe internal construction of battery.
6. Differentiate between series circuits, parallel circuits, and series/parallel combination circuits.

LEARNING OUTCOME # 3.2 Remove and replace master cylinder.

TASK # 3.2.1 Remove and replace master cylinder.

PERFORMANCE STANDARD: Hydraulic system must operate according to manufacturer's specifications with no leaks or air in hydraulic system.

TOOLS, RESOURCES, EQUIPMENT AND SITUATION(S):

Standard tool kit
Drain pan
Manufacturer's specifications
Personal safety equipment

PERFORMANCE STEPS:

1. Lock out system so it can not be operated.
2. Drain brake fluid from master cylinder.
3. Disconnect brake pedal from master cylinder push rod.
4. Disconnect hydraulic lines from master cylinder.
5. Plug or cap ends of lines.
6. Loosen mounting bolts and remove old cylinder.
7. Bench bleed new cylinder.
8. Fill to specified level.
9. Install new master cylinder.
10. Align push rod with pedal linkage.
11. Finger tighten counting bolts.
12. Connect brake lines.
13. Tighten cylinder mountings.
14. Connect master cylinder push rod to brake pedal.
15. Adjust free play as necessary.
16. Bleed lines.
    a. Check manufacturer's manual.
    b. Open valve, hold-down brake pedal.
    c. Close valve.

d. Release brake pedal.
e. Repeat as necessary.

17. Tighten connections.
18. Re-fill master cylinder reservoirs.
19. Check for leaks.
20. Re-fill as necessary.

ENABLING OBJECTIVES:

1. Explain the relevant safety practices and procedures.
2. List and identify the parts of a master cylinder.
3. Describe fluid flow through a master cylinder.
4. Explain the effects of air or leaks in the system.
5. Describe types of fittings and lines than can be used safely on a hydraulic unit.
6. Distinguish between slave cylinders and wheel cylinders.
7. Explain the characteristics of fluids used in master cylinders.

UNIT #4 Electrical

LEARNING OUTCOME # 4.1 Read and interpret electrical schematics/diagrams.

TASK # 4.1.1 Read and interpret electrical schematics/diagrams.

PERFORMANCE STANDARD: Requirements for each item must be determined accurately: (1) type of outlet, fixtures and their location (2) type and location of special purpose outlets (3) cable run location (4) size and wattage of circuits and load center locations.

TOOLS, RESOURCES, EQUIPMENT AND SITUATION(S):

Electrical schematics/diagrams
National Electrical Code

PERFORMANCE STEPS:

1. Read schematic/diagrams to determine:
   a. Location and amperage of breaker.
   b. Location of load center and control unit.
   c. Type and size of wire/cable.
   d. Determine voltage and amperage of serviced unit.
2. Calculate cable size and circuit amperage and wattage draw.

ENABLING OBJECTIVES:

1. Explain the relevant safety practices and procedures.
2. Explain Ohm's law and power calculations.
3. Explain cable/wire size and load capacities.
4. Describe connector styles and connection technique.
5. Differentiate between series circuit, parallel circuit, and series/parallel combination circuits.
6. Describe how switches, outlets, breakers, and fuses function.
7. Explain color code and circuit polarity.

LEARNING OUTCOME # 4.2 Remove and replace fuses, breakers, and fusible links.

TASK(S) # 4.2.1 Remove and replace fuses and fuse links.
4.2.2 Remove and replace breakers.

TASK # 4.2.1 Remove and replace fuses and fuse links.

PERFORMANCE STANDARD: Fuse must be of specified amperage and securely installed according to National Electrical code and local code having jurisdiction.

TOOLS, RESOURCES, EQUIPMENT AND SITUATION(S):

Standard tool kit
Electrical test equipment (continuity tester, voltmeter, volt-ohmmeter)
Fuse puller
Local codes and regulations
National Electrical Code
Personal protective safety equipment
Screw drivers

PERFORMANCE STEPS:

1. Lock out equipment power source.
2. Locate faulty fuse with VOM.
3. Remove faulty fuse, using fuse puller.
4. Connect lamp or continuity tester.
5. Troubleshoot circuit until fault is determined.
6. Correct fault.
7. Inspect circuit for cause of fault.
8. Correct cause of fault.
9. Select replacement fuse.
   a. Complete fuse, or
   b. Fuse strip, if replacement type.
10. Install new fuse in box.
11. Unlock/turn on power and test operation.

ENABLING OBJECTIVES:

1. Explain the relevant safety practices and procedures.
2. Explain the relevant sections of National Electrical code.
3. Explain the relevant sections of local code.
4. Identify current flow through the fuse.
5. Identify the parts of fuse.
6. Explain calculating circuit amperage.
7. Explain starting amperage draw and running amperage.
8. Demonstrate how to connect a voltmeter.
9. Explain how to read a voltmeter.
10. Demonstrate how to use an ohm meter.
11. Explain how to read an ohm meter.
12. Identify causes of fuse failure.

TASK # 4.2.2 Remove and replace breakers.

PERFORMANCE STANDARD: Breakers must be identified for use with panel, must be of required size and type, and must be fully inserted to engage with busses.

TOOLS, RESOURCES, EQUIPMENT AND SITUATION(S):

Standard tool kit
Assorted breakers
National Electrical Code
Personal safety equipment
Voltage tester

PERFORMANCE STEPS:

1. Turn power off.
2. Determine that power is off by checking conductor(s) at point of connections(s) with voltage tester.
3. Remove one breaker from panel.

4. Remove conductor from old breaker.
5. Connect new breaker to conductor.
6. Install breaker to panel.
7. Replace each breaker.
8. Turn power on.
9. Assure required operation.

ENABLING OBJECTIVES:

1. Explain the relevant safety practices and procedures.
2. Explain the relevant sections of National Electrical Code.
3. Describe the functions of a circuit breaker and how it operates.
4. Explain rating of circuit breakers and their relationship to cable/wire capacity.
5. Explain the effects of not engaging the breakers fully into the busses.

LEARNING OUTCOME # 4.3 Change rotation of three-phase electric motor.

TASK # 4.3.1 Change rotation of three-phase electric motor.

PERFORMANCE STANDARD: Motor must operate smoothly and must rotate in reverse direction.

TOOLS, RESOURCES, EQUIPMENT AND SITUATION(S):

- Standard tool kit
- Electric circuit tester (continuity, voltage, VOM)
- Local code
- Manufacturer's manual
- National Electrical Code
- Personal safety equipment
- Screwdrivers/wrenches
- Wiping rags

PERFORMANCE STEPS:

1. Turn off/lock out equipment power.
2. Clean area around motor plate.
3. Remove motor plate/junction box cover.
4. Change wires as specified.
5. Tighten wires.
6. Re-fasten motor plate/junction box cover.
7. Unlock/turn on power.
8. Check rotation.
9. Remove lock/tag on motor.

ENABLING OBJECTIVES:

1. Explain the relevant safety practices and procedures.
2. Explain the relevant sections of National Electrical Code.
3. Explain the relevant local codes and regulations.
4. Identify the parts of a three-phase motor.
5. Describe the current flow in a three-phase motor.
6. List the advantages and disadvantages of three-phase motors.
7. Identify the various types of connectors available.
8. Calculate cable size.
9. Differentiate between starting current/amperage and running current/amperage.

LEARNING OUTCOME: # 4.4 Clean and replace faulty electrical cords and plugs on electric motor.

TASK # 4.4.1 Clean and replace faulty electrical cords and plugs on electric motor.

PERFORMANCE STANDARD: Cords, and plugs must be of specified size(s), securely connected, and must be insulated according to electrical code. There must be no arcing or fuses blown when plug is inserted into specified circuit.

TOOLS, RESOURCES, EQUIPMENT AND SITUATION(S):

Standard tool kit	National Electrical Code
Clean rag	Personal safety equipment
Continuity tester	Wire cutters
Local code and regulations	Wire strippers

PERFORMANCE STEPS:

1. Turn off/lock out machine power.
2. Inspect cord and plug for any cause of failure.
   a. Wipe with clean rag if necessary.
3. Select replacement cord and cut to length.
4. Remove faulty cord(s) from machine/device.
5. Remove plug from cord.
6. Determine cause of faulty cord/plug.
7. Correct cause of fault.
8. Install plug on new cord.
9. Install new cord on machine/device.
10. Test for correct polarity with continuity tester.
11. Plug in machine/device.
12. Unlock/turn on power.
13. Test operation of machine/device.

ENABLING OBJECTIVES:

1. Explain the relevant safety practices and procedures.
2. Explain the relevant sections of National Electrical Code.
3. Explain the relevant sections of the local code.
4. Describe types of cords and their application.
5. Explain polarity for wiring.
6. Differentiate between line, hot, neutral, and ground, polarized plug.
7. Describe how to connect voltage tester into circuit.
8. Describe how to connect and read a continuity tester.

LEARNING OUTCOME # 4.5 Replace electric motor.

TASK # 4.5.1 Replace electric motor.

PERFORMANCE STANDARD: Electric motor must deliver full and uniform power without vibration, squealing, binding, rubbing or overheating in accordance with manufacturer's specifications, electrical code.

TOOLS, RESOURCES, EQUIPMENT AND SITUATION(S):

Standard tool kit	Manufacturer's manuals
Chain	National Electrical Code
Dial indicator	Shim stock
Lifting device	Straightedge/wire
Local code	Wiping rags

PERFORMANCE STEPS:

1. Turn off/lock out equipment power.
2. Remove safety guards, if necessary.
3. Inspect motor base unit for fit.
   a. Adapt as necessary.
4. Inspect motor drive coupling for shaft fit.
   a. Replace as necessary.
5. Set motor on base unit.
6. Align coupling vertically with dial indicator.
7. Align coupling horizontally with dial indicator.
   a. Shim as necessary.
8. Install coupling.
9. Tighten all nuts and bolts.
10. Replace safety guards, if necessary.
11. Unlock/turn on power.
12. Test motor.

ENABLING OBJECTIVES:

1. Explain the relevant safety practices and procedures.
2. Explain the relevant sections of National Electrical Code.
3. Explain the relevant sections of the local code.
4. Explain how an electric motor functions.
5. Describe the five types of electric motors and their applications.
6. Differentiate between starting current/amperage and running current/amperage.
7. Explain calculating cable/wire size to feed motor.
8. Explain setting up and reading dial indicator.
9. Identify different styles of drive couplings.
10. Explain techniques of controlling motors.

LEARNING OUTCOME # 4.6 Use electrical test equipment.

TASK # 4.6.1 Use electrical test equipment.

PERFORMANCE STANDARD: Demonstrate ability to properly and safely connect meter into circuit. Demonstrate ability to read meter accurately.

TOOLS, RESOURCES, EQUIPMENT AND SITUATION(S):

Ammeter	Maintenance mechanic tool box
Appropriate manuals	Ohm meter
Continuity	Voltmeter

PERFORMANCE STEPS:

1. Select appropriate scale setting.
2. Calibrate meter.
3. Attach probes to meter according to manual specifciations.
4. Wire probes into circuit according to manual specifications.
5. Read meter scale.

ENABLING OBJECTIVES:

1. Explain relevant safety practices and procedures.
2. Visually identify different meters.
3. Explain differences between series and parallel configuration.
4. Describe how meters function.
5. Identify the different types of meter movements.
6. Explain meter calibration.

UNIT # 5 Welding

LEARNING OUTCOME # 5.1 Braze and gas weld ferrous/non-ferrous metal.

TASK(S) # 5.1.1 Braze ferrous/non-ferrous metal.
5.1.2 Gas weld ferrous/non-ferrous metal.

TASK # 5.5.1 Braze ferrous/non-ferrous metal.

PERFORMANCE STANDARD: Brazed joints must have uniform heads and bond with smooth even puddles without holes, craters or undercut.

TOOLS, RESOURCES, EQUIPMENT AND SITUATION(S):

- Abrasive
- Apron
- Clamps
- Oxyacetylene torches
- Oxyacetylene welding equipment
- Personal safety equipment
- Soapstone or chalk
- Steel brush
- Tongs
- Welding goggles

PERFORMANCE STEPS:

1. Set up welding equipment.
2. Ventilate work area.
3. Inspect work area for flammable materials.
   a. Remove any flammable materials.
4. Prepare metal for brazing.
   a. Clean metal.
   b. Grind metal.
   c. Position metal.
5. Select torch tip, filler rod, brazing flux.
6. Turn on/light and adjust torch to neutral or slight oxidizing flame.
7. Heat joint and filler rod.
8. Apply flux.
9. Tack joint on each end.
10. Check alignment.
11. Tin joint and braze.
12. Shut off equipment and bleed lines.
13. Clean and cool workpiece(s).
14. Check braze.

ENABLING OBJECTIVES:

1. Explain the relevant safety practices and procedures.
2. Identify different types of brazing rods and their

applications.
3. Identify different types of fluxes and their applications.
4. Identify parts of oxyacetylene welding system.
5. Differentiate between the different size tips for an oxyacetylene torch.
6. Explain possible outcome when workpiece is not tacked before brazing.
7. Explain the effects of heat on material.
8. List materials that are not easily brazed.
9. Identify a neutral flame and an oxidizing flame.
10. Explain tempering and annealing process.
11. Explain the procedures for surface preparation.

TASK # 5.1.2 Gas weld ferrous/non-ferrous metal.

PERFORMANCE STANDARD: Welds must be as strong as workpieces. Visual inspection must show even weld beads, penetration of parent metal and complete fusion with smooth even beads without cracks, holes, craters or undercut.

TOOLS, RESOURCES, EQUIPMENT AND SITUATION(S):

- Abrasive
- Apron
- Brush
- Clamps
- Oxyacetylene welding equipment
- Oxyacetylene welding torches
- Personal safety equipment
- Soapstone or chalk
- Tongs
- Welding goggles

PERFORMANCE STEPS:

1. Set up welding equipment.
2. Ventilate work area.
3. Inspect work area for flammable materials.
   a. Remove if necessary.
4. Prepare metal to be welded.
   a. Clean.
   b. Grind.
   c. Position.
5. Select torch tip, filler rod, and (flux for non-ferrous metals).
6. Open tank valves and adjust pressure to specified readings on regulators.
7. Turn on/light and adjust torch to neutral flame.
8. Preheat workpiece.
9. Apply flux.
10. Weld joints to work order specifications.
11. Shut off equipment and bleed lines.

12. Clean and allow weld to cool.
13. Check weld for undercut, cracks, or porosity.

LEARNING OUTCOME # 5.2 Cut metal using cutting torch.

TASK # 5.2.1 Cut metal using cutting torch.

PERFORMANCE STANDARD: Cuts must be within tolerance of American Welding Society criteria for cut surfaces.

TOOLS, RESOURCES, EQUIPMENT AND SITUATION(S):

- Apron
- Center punch
- Hammer
- Manufacturer's specifications
- Oxyacetylene cutting equipment
- Oxyacetylene cutting torches
- Personal safety equipment
- Rule
- Soapstone or chalk
- Steel brush
- Tongs
- Welding goggles

PERFORMANCE STEPS:

1. Set up welding equipment.
2. Ventilate work area.
3. Inspect work area for flammable materials.
   a. Remove flammable materials.
4. Post fire watch if necessary.
5. Determine grade of steel by:
   a. Spark stream, or
   b. Code number.
6. Lay out cuts.
7. Select torch tip according to equipment manufacturer's specifications.
8. Open tank valves and adjust pressure to specified readings on regulators according to manufacturer's specifications.
9. Turn on/light and adjust torch to neutral flame with cutting oxygen.
10. Cut metal to specifications.
11. Close tank valves and bleed lines.
12. Cool metal.
13. Check cuts and dimensions.,

ENABLING OBJECTIVES:

1. Explain the relevant safety practices and procedures.
2. Identify the various grades of steel.
3. Identify the parts of cutting torch.
4. Identify tank pressure setting for the various torch tip sizes.
5. Define the terms ferrous metal and non-ferrous metal.
6. Explain tempering and annealing processes.
7. Explain layout procedure.

LEARNING OUTCOME # 5.3 Shape metals using heat.

TASK # 5.3.1 Shape metals using heat.

PERFORMANCE STANDARD: Metal workpiece must conform to work specifications to within + or - 1/16" and be free of scales, puddles, holes and cracks.

TOOLS, RESOURCES, EQUIPMENT AND SITUATION(S):

- Abrasive
- Anvil
- Apron
- Brush
- Clamps
- Hammers
- Oxyacetylene welding equipment and torches
- Pattern or measuring devices
- Personal safety equipment
- Soapstone or chalk
- Tongs
- Welding goggles/safety glasses
- Work order

PERFORMANCE STEPS:

1. Set up welding equipment.
2. Ventilate work area.
3. Inspect work area for flammable materials.
   a. Remove flammable materials.
4. Lay out bends/shapes/forms on metal stock.
5. Select approaches.
6. Select hand tools.
7. Position metal
8. Select torch tip.
9. Open tanks and adjust pressure to equipment manufacturer's specifications.

10. Turn on/light and adjust torch to neutral flame.
11. Heat metal to cherry red.
12. Shape (form) metal to specifications in work order.
    NOTE: Metal may have to be heated several times, with a little bending after each time.
13. Shut off welding equipment and bleed lines.
14. Cool and check to specifications.

ENABLING OBJECTIVES:

1. Explain the relevant safety practices and procedures.
2. Interpret the drawing or sketches to determine type of material to be formed.
3. Explain effects of cold working metal.
4. Explain operation of oxyacetylene unit.
5. Explain the selection procedure for torch tip size.

LEARNING OUTCOME # 5.4 Weld ferrous/non-ferrous metals using metallic inert gas, tungsten inert gas, and shielded metal arc welding processes.

TASK(S) #
- 5.4.1 Weld ferrous/non-ferrous metals using metallic inert gas welding processes.
- 5.4.2 Weld ferrous/non-ferrous metals using tungsten inert gas welding processes.
- 5.4.3 Weld ferrous/non-ferrous metals using shielded metal arc welding processes.

TASK # 5.4.1 Weld ferrous/non-ferrous metals using metallic welding processes.

PERFORMANCE STANDARD: Weld must be as strong as original material and part or workpiece must function as designed. Visual inspection of joints must show smooth and continuous welds, complete penetration, fusion between weld bead and base metal, with no cracks, undercutting or overlap.

TOOLS, RESOURCES, EQUIPMENT AND SITUATION(S):

Abrasive	Personal safety equipment
Apron	Tongs
Brush	Welder's helmet w/shade
Clamps	Welding goggles/safety glasses
MIG welding unit	

PERFORMANCE STEPS:

1. Set up equipment.
2. Ventilate work area.
3. Inspect work area for flammable materials.
   a. Remove flammable materials.
4. Prepare metal to be welded.
   a. Clean
   b. Grind
   c. Position
5. Position all cables and hoses so they are neither burned or damaged.
6. Attach ground cable.
7. Turn on electrical equipment.
8. Turn on/adjust water flow.
9. Turn on/adjust shielding gas.
10. Adjust wire feed, voltage, amperage and stick-out.
11. Weld joints using fillet and groove welds in all positions.
12. Shut off equipment.
13. Clean welds and cool.
14. Check/test welds.

ENABLING OBJECTIVES:

1. Explain the relevant safety practices and procedures.
2. Describe the components of a MIG welder.
3. Describe how a MIG welder functions.
4. Explain the advantages of MIG welding.
5. List types of metals that can be welded with MIG.
6. Differentiate between striking an arc on MIG welder and a shielded arc welder.
7. Identify special conditions for welding in vertical, horizontal, and overhead positions.
8. Identify filler rods available and their applications.

TASK # 5.4.2 Weld ferrous/non-ferrous metals using tungsten inert gas welding processes.

PERFORMANCE STANDARD: Weld must be as strong as workpieces. Visual inspection of joints must show smooth and con tinuous welds, complete penetration, fusion between weld bead and base metal, and no cracks, undercutting or overlap.

TOOLS, RESOURCES, EQUIPMENT AND SITUATION(S):

- Abrasive
- Apron
- Brush (varies with material)
- Clamps
- Electrodes
- Personal safety equipment
- Soapstone or chalk
- TIG welding unit
- Tongs
- Welding goggles/safety glasses
- Welder's helmet with shade
- Work order

PERFORMANCE STEPS:

1. Set up equipment.
2. Ventilate work area.
3. Inspect work area for flammable materials.
   a. Remove flammable materials.
4. Prepare metal to be welded.
   a. Clean.
   b. Grind.
   c. Position.
5. Position all cables and hoses so they are neither burned or damaged.
6. Attach ground cable.
7. Turn on electrical equipment.
8. Turn on and check water flow as required.
9. Turn on and adjust shielding gas.
10. Select/adjust tungsten.
11. Adjust current.
12. Adjust high frequency.
13. Weld joints in all positions according to work order.
14. Shut off equipment.
15. Clean welds and cool.
16. Check/test welds.

ENABLING OBJECTIVES:

1. Explain the relevant safety practices and procedures.
2. Describe components of a TIG welder.
3. Describe how a TIG welder functions.
4. Explain advantages and disadvantages of TIG system.
5. Differentiate between striking an arc with a TIG unit and a shielded arc welder.
6. List type of metals that can be welded with TIG equipment.
7. Identify special conditions for welding in various positions: horizontal, vertical, and overhead.

TASK # 5.4.3 Weld ferrous/non-ferrous metals using shielded metal arc welding processes.

PERFORMANCE STANDARD: Weld must be as strong as workpiece. Visual inspection must show smooth and continuous welds, fusion between weld bead and base metal, complete penetration, and no cracks, undercutting, or overlap.

TOOLS, RESOURCES, EQUIPMENT AND SITUATION(S):

- Abrasive
- Apron
- Arc-welder
- Clamps
- Personal safety equipment
- Slag hammer
- Steel brush
- Stick electrodes
- Tongs
- Welding goggles/safety glasses
- Welding helmet/shade
- Work order

PERFORMANCE STEPS:

1. Set up arc-welder.
2. Ventilate work area.
3. Inspect work area for flammable materials.
   a. Remove flammable materials.
4. Prepare metal to be welded.
   a. Clean.
   b. Grind.
   c. Position.
5. Attach ground cable.
6. Turn on and adjust welding machine.
7. Select electrode.
8. Weld joint(s) according to work order specifications.
   NOTE: Slag must be removed between passes.
9. Shut off welder.
10. Clean finished weld.
    a. Allow to cool.
11. Test.

ENABLING OBJECTIVES:

1. Explain the relevant safety practices and procedures.
2. Describe components of metal shielded arc welder.
3. Describe how a metal shielded welder functions.
4. Identify special conditions for welding in various positions, horizontal, vertical, and overhead.
5. Describe how to strike arc.
6. Differentiate between AC and DC welding.

LEARNING OUTCOME # 5.5 Remove and replace gas welding regulators.

TASK # 5.5.1 Remove and replace gas welding regulators.

PERFORMANCE STANDARD: Gas welding regulators must be installed or replaced and operate without leaks according to manufacturer's specifications.

TOOLS, RESOURCES, EQUIPMENT AND SITUATION(S):

- Apron
- Manufacturer's specifications
- Personal safety equipment
- Torch wrench or other close-fitting wrenches
- Welding goggles/safety glasses

PERFORMANCE STEPS:

1. Tag out equipment.
2. Check to see that cylinder (fuel and oxygen) valves are closed.
   a. Close as required.
3. Remove pressure from hose lines (bleed) until regulators read "zero" by loosening regulator adjustment screws.
4. Disconnect torch hoses from regulator/check valve by loosening nuts at regulator outlet.
   CAUTION: FUEL = LEFT HAND THREAD. OXYGEN = RIGHT HAND THREAD.
5. Place hose/torch assembly in clean area free of oil or grease.
   CAUTION: OXYGEN UNDER PRESSURE IN CONTACT WITH GREASE CREATES EXPLOSIONS.
6. Disconnect regulators from cylinder valves.
7. Place in clean area free of oil or grease.
8. Install regulators on cylinders.
9. Check regulator inlet screens and tail pieces for cleanliness and smooth seats.

<u>New Cylinder.</u>

a. Crack cylinder (rapid on-off) to clear of dust, dirt or other foreign particles.
b. Clean regulator inlet seat by wiping with dry cloth.
c. Insert regulator seat into regulator valve.
d. Tighten nut.

<u>Continued Use Cylinder.</u>

a. Clean regulator inlet seat by wiping with dry cloth.

b. Insert regulator seat into regulator valve.
c. Tighten nut.

10. Reconnect hoses to regulator/check valve.
11. Open tank valves to desired pressures.
12. Check for leaks with soapy water.
13. Select/install torch.
14. Turn on/light/adjust torch to manufacturer's specifications.
15. Shut off welding equipment and bleed lines.
16. Remove tag.

ENABLING OBJECTIVES:

1. Explain the relevant safety practices and procedures.
2. Describe the component parts of a gas welder.
3. Identify the parts of a torch.
4. Identify the parts of the regulator.
5. Explain right and left hand threading.
6. Define the terms: cracking valves, bleeding, new cylinder, continued use of cylinder.
7. Explain the importance of care in handling of cylinders.
8. Describe the procedures for the storage of cylinders.

UNIT #6 Plumbing

LEARNING OUTCOME # 6.1 Cut metal stock with power or handsaw.

TASK # 6.1.1 Cut metal stock with power or handsaw.

PERFORMANCE STANDARD: Workpiece must cut within 1/32 inch of specifications.

TOOLS, RESOURCES, EQUIPMENT AND SITUATION(S):

File	Personal safety equipment
Hacksaw blades	Power saw
Hacksaw frame	Vise

PERFORMANCE STEPS:

1. Lay out stock.
2. Select blade.
3. Mount blade in saw frame/chuck.
4. Secure workpiece in vise.
5. Saw workpiece to specifications.
6. Smooth edges with file.

ENABLING OBJECTIVES:

1. Explain the relevant safety practices and procedures.
2. Demonstrate the proper use of a power saw.
3. Describe the cutting action of blade.
4. Identify the term teeth per inch and how to calculate the desired teeth per inch for material being cut.
5. Calculate the cutting speed for power saws.
6. Explain reading a rule.
7. Explain reading blueprint or sketch for dimensions.

LEARNING OUTCOME # 6.2 Cut threads with taps or dies.

TASK(S) # 6.2.1 Cut threads with taps.
6.2.2 Cut threads with dies.

TASK # 6.2.1 Cut threads with taps.

PERFORMANCE STANDARD: Threads must e smooth and in compliance with specifications.

TOOLS, RESOURCES, EQUIPMENT AND SITUATION(S):

Center punch
Deburring tool
Drill motor
Drills
Hammer
Holding device
Personal safety equipment
Prick punch
Scribe
Square/centering head
Tap handles
Taps
Thread plug gauge

PERFORMANCE STEPS:

1. Secure workpiece in holding device.
2. Locate hole; prick punch, recheck, and center punch.
3. Select tap drill, and drill hole.
4. Select tap and tap wrench.
5. Tap hole and lubricate as necessary.
   a. Use starter tap, check for alignment as necessary.
   b. Reverse tap to clear cuttings as necessary.
   c. Use plug tap or bottom tap as needed.
6. Debur hole if necessary.
7. Remove/blow out chips with compressed air.
   CAUTION: PROTECT FACE.

8. Inspect for compliance with specifications with thread plug gauge.
9. Clean up.

ENABLING OBJECTIVES:

1. Explain the relevant safety practices and procedures.
2. Differentiate between SAE fine, SAE course, metric and pipe threads.
3. Explain the type of lubricants and coolants used with taps.
4. Describe difference between starter, bottom, and plug tap.
5. Demonstrate deburring procedures.
6. Differentiate between consideration for tapping ferrous and non-ferrous metals.
7. Describe the technique for tapping plastics.
8. Explain reading blueprints for dimensions.
9. Differentiate between a tap and a die.

TASK # 6.2.2 Cut threads with dies.

PERFORMANCE STANDARD: Threads must be smooth and in compliance with specifications.

TOOLS, RESOURCES, EQUIPMENT AND SITUATION(S):

Dies for cutting threads
Diestock (die holder
File or grinder
Holding device (vise)
Personal safety equipment
Rule
Square
Thread ring gauge

PERFORMANCE STEPS:

1. Secure workpiece in vise.
2. Select die.
3. Mount die in diestock (die holder).
4. Bevel end of workpiece with file or grinder.
5. Mount and square diestock to workpiece.
6. Cut threads and lubricate as necessary.
7. Check threads to specification with thread ring gauge.
8. Finish bevel and debur as necessary.

ENABLING OBJECTIVES:

1. Explain the relevant safety practices and procedures.
2. Explain type of lubricants and coolant used with die.
3. Explain the deburring process.
4. Read and interpret blueprints for dimensions.
5. Explain split dies and their advantages and disadvantages.

LEARNING OUTCOME # 6.3 Remove damaged screws or bolts.

TASK # 6.3.1 Remove damaged screws or bolts.

PERFORMANCE STANDARD: Threaded hardware must be removed and fit of original tapped hole must be maintained.

TOOLS, RESOURCES, EQUIPMENT AND SITUATION(S):

- Center punch
- Drill assortment
- Electric drill motor
- Personal safety equipment
- Screw extractors
- Tap wrenches
- Taps
- Wiping rags
- Work-holding device

PERFORMANCE STEPS:

1. Lock out equipment power.
2. Select drill.
3. Center punch in center of damaged screw or other threaded fastener.
   NOTE: Anneal/normalize if necessary.
4. Drill hole in center of damaged fastener.
5. Place screw extractor in hole.
6. Remove damaged screw/fastener.
7. Clean out hole.
8. Inspect threads for burrs and damage.
9. Re-tap if necessary.

ENABLING OBJECTIVES:

1. Explain the relevant safety practices and procedures.
2. Differentiate between tempering and annealing procedures for ferrous and non-ferrous metals.
3. List available sizes and styles of screw extractors.
4. Describe size and shape of pilot hole for screw extractors.
5. List and describe thread forms.
6. Demonstrate how to use a tap.
7. Demonstrate how to use a torch for annealing.

LEARNING OUTCOME # 6.4 Grind surfaces using portable electric hand grinder.

TASK # 6.4.1 Grind surfaces using portable electric hand grinder.

PERFORMANCE STANDARD: Surfaces must be ground to specifications.

TOOLS, RESOURCES, EQUIPMENT AND SITUATION(S):

Personal safety equipment	Table of abrasives
Portable electric grinder with grinding attachments	Wiping rags
	Workpiece

PERFORMANCE STEPS:

1. Inspect grinder for safety conditions.
2. Ring test grinding wheel for cracks.
   a. Replace if necessary.
3. Select/mount abrasive attachment (grinding wheel).
4. Secure workpiece in holding device.
5. Grind to specifications.
   CAUTION: SPARKS SHOULD BE DIRECTED AWAY FROM OPERATOR.
6. Clean and inspect surfaces.

ENABLING OBJECTIVES:

1. Explain the relevant safety practices and procedures.
2. Differentiate between course, medium, fine and grit numbers for wheels and abrasives.
3. Explain how to read blueprints/drawings for desired surface finish.

UNIT #7 Drill Press

LEARNING OUTCOME # 7.1 Lubricate drill press.

TASK: 7.1.1 Lubricate drill press.

PERFORMANCE STANDARD: Oil reservoirs must be full and all grease fittings must be greased/lubricated in accordance with manufacturer's specifications.

TOOLS, RESOURCES, EQUIPMENT AND SITUATION(S):

Grease gun	Screw drivers
Manufacturer's manual	Wiping rags
Oil can	Wrench, open/box end
Personal safety equipment	

PERFORMANCE STEPS:

1. Lock out drill press power.
2. Consult manufacturer's manual to determine lubrication specifications and locations.
3. Wipe clean oil points.
4. Wipe clean grease fittings.
5. Check condition of grease fittings.
   a. Replace if necessary.
6. Clean machine surface/T-slots.
7. Check oil level gauges where applicable.
   a. Check for leaks.
8. Fill oil reservoirs according to manufacturer's specifications.
9. Re-check oil level gauges.
10. Lubricate grease fittings according to specifications.
11. Oil lightly machined surfaces.
12. Wipe off excess lubricants.
13. Unlock power.

ENABLING OBJECTIVES:

1. Explain the relevant safety practices and procedures.
2. Identify the parts of a drill press.
3. Explain how a drill press operates.
4. Identify lubrication points from drawings.
5. Describe types of lubricants and their applications.
6. Identify solvents that can be utilized on machined surfaces.
7. Differentiate between cast iron and forged parts of drill press.

LEARNING OUTCOME #	7.2	Counterbore, countersink,drill holes, and hone holes using drill press.
TASK(S) #	7.2.1	Counterbore using drill press.
	7.2.2	Countersink using drill press.
	7.2.3	Drill holes using drill press.
	7.2.4	Hone holes using drill press.
TASK #	7.2.1	Counterbore using drill press.
PERFORMANCE STANDARD:		Size, depth and concentricity of counterbore must be within specifications.

TOOLS, RESOURCES, EQUIPMENT AND SITUATION(S):

- Counterbore
- Drill press with accessories
- Holding device
- Machinery's handbook or table for selecting counterbore/speeds/feed
- Personal safety equipment
- Rule depth gauge
- Table clamps
- Workpiece (with pilot hole)

PERFORMANCE STEPS:

1. Verify material, if necessary, for counterbore selection, cutting speed and feed.
2. Select/mount counterbore to fit pilot hole.
3. Secure workpiece in holding device and clamp to table.
4. Align counterbore with pilot hole in workpiece.
5. Select/set speed control/start drill press.
6. Counterbore hole to specified depth.
   a. Lubricate as necessary.
7. Turn off drill press.
8. Check counterbore for accuracy.
9. Remove counterbore.
10. Remove workpiece.

ENABLING OBJECTIVES:

1. Explain the relevant safety practices and procedures.
2. Describe techniques for securing work to the table.
3. Differentiate between drilling, boring, counterboring, spotfacing, reaming, and honing.
4. Identify using the machinist's handbook, the correct speed and feed rate for counterbore diameter and material being machined.
5. Explain work alignment techniques.
6. Describe how to drill pilot hole.
7. Explain how to use ruled depth gauge.
8. Describe techniques for checking counterbore diameter.
9. Identify lubricants and cutting fluids used for counterboring.

TASK # 7.2.2 Countersink using drill press.

PERFORMANCE STANDARD: Surface must be smooth and free from burrs and chatter marks, and concentric with hole in accordance with specifications.

TOOLS, RESOURCES, EQUIPMENT AND SITUATION(S):

Countersinks	Machinist's handbook
Drill press with accessories	Personal safety equipment
Holding device	Table clamps
	Workpiece specifications

PERFORMANCE STEPS:

1. Verify workpiece material for countersink selection and cutting speeds/feeds.
2. Select/mount countersink.
3. Secure workpiece in holding device/clamp on table.
4. Align countersink with hole in workpiece.
5. Select/set speed.
6. Start drill press.
7. Countersink hole.
   a. Lubricate as necessary.
8. Turn off drill press.
9. Check countersink in accordance with specifications.
10. Remove countersink.
11. Remove workpiece.

ENABLING OBJECTIVES:

1. Explain the relevant safety practices and procedures.
2. Identify using machinist handbook the correct speed and feed rate for countersinking the material being machined.
3. Describe how to drill holes on drill press.
4. Explain how to check countersink size with specifications.
5. Identify lubricants and cutting fluids used for countersinking.

TASK # 7.2.3 Drill holes using drill press.

PERFORMANCE STANDARD: Hole(s) must have smooth finish within accuracy of +0.005" of nominal drill size and must locate within +- 0.010" of specifications.

TOOLS, RESOURCES, EQUIPMENT AND SITUATION(S):

Center punch	Personal safety equipment
Chuck wrench	Prick punch
Deburring tool	Scribe
Drill size gauge	Set of drills
Inside-outside dial vernier caliper	Small hole gauges
Machinist's handbook or drilling speed/feed/ drill tables	Table clamps or holding device

PERFORMANCE STEPS:

1. Verify workpiece material for selection of drill/ speed/feed.
2. Verify specifications for size/type of hole (through or blind hole).
3. Lay out holes with scribe, prick punch, re-check location.
4. Center punch.
5. Select/mount pilot drill in chuck.
   a. Check condition of drill.
6. Secure workpiece in holding device/clamp to table.
7. Select/set speed.
8. Pilot drill.
   a. Re-check location.
9. Stop drill press.
10. Remove pilot drill.
11. Select/mount drill in chuck.
    a. Check condition of drill.
    b. Step drill and reset speed/feed as necessary.
12. Select/set speed.
13. Final drill.
14. Lubricate as necessary.
15. Turn off drill press.
16. Remove drill.
17. Remove workpiece.
18. Deburr as necessary.

ENABLING OBJECTIVES:

1. Explain the relevant safety practices and procedures.
2. Identify the correct speed and feed rate for diameter of drill and material being machined using the Machinist's Handbook.
3. Explain reading blueprints for layout information.
4. Demonstrate work alignment techniques.
5. Identify lubricants and cooling fluids used for drilling on drill press.
6. Describe techniques for checking diameter and depth of drilled hole.

TASK # 7.2.4 Hone holes using drill press.

PERFORMANCE STANDARD: Hole must have smooth finish, and size must be within tolerance of specifications or Total Inch Runout (TIR) of 0.0005".

TOOLS, RESOURCES, EQUIPMENT AND SITUATION(S):

Chuck wrench	Outside micrometer
Drill press	Personal safety equipment
with accessories	Small hole gauges/pin gauges
Holding device	Table clamps
Hones	Telescoping gauge
Machinist's handbook	

PERFORMANCE STEPS:

1. Check rough size and condition of hole.
2. Determine finished size of honed hole.
3. Select/chuck hone.
4. Align hone with hole in workpiece.
5. Secure workpiece in holding device/clamp to table.
6. Select speed/set speed, control/start drill press.
7. Hone hole to specifications.
   a. Lubricate as needed.
8. Turn off drill press.
9. Clean hole.
10. Check size of hole with gauge.
11. Remove hone from chuck.
12. Remove workpiece from table.

ENABLING OBJECTIVES:

1. Explain the relevant safety practices and procedures.
2. Identify using machinist handbook, the correct speed and feed rate for size of hone and material being honed.
3. Explain drilling and boring on the drill press.
4. Describe techniques for aligning work to hone.
5. Identify lubricants and cutting fluids used for honing.
6. Explain how to set and read telescoping micrometer.
7. Identify grades/grits of honing stones.
8. Describe cutting action of hone.

UNIT #8 Grinding

LEARNING OUTCOME # 8.1 Clean, lubricate, dress grinding wheel, and change coolant in grinding machine.

TASK(S) #	8.1.1	Clean and lubricate grinding machines.
	8.1.2	Dress grinding wheel for grinding machine.
	8.1.3	Change coolant in grinding machine.
TASK #	8.1.1	Clean and lubricate grinding machine.

PERFORMANCE STANDARD: Machined/sliding/finished surfaces must be clean and free of grit and dirt. Oil level gauges must show "full". All grease fittings and oil points must be lubricated according to manufacturer's specifications.

TOOLS, RESOURCES, EQUIPMENT AND SITUATION(S):

Grease gun	Oil cans
Maintenance mechanic's tool box (hand tools)	Personal safety equipment
Manufacturer's manual	Wiping rags

PERFORMANCE STEPS:

1. Turn off/lock out grinder power.
2. Consult manufacturer's manual for lubrication specifications/locations.
3. Disassemble as necessary.
4. Wipe clean all machined finished surfaces (ways, slides, etc.).
5. Locate/wipe clean lubrication points/grease fittings according to manufacturer's manual.
6. Select lubricants.
7. Fill oil reservoirs.
8. Lubricate grease fittings.
9. Check oil level gauges.
10. Wipe off excess lubricants as necessary.
11. Check for and remove grit on sliding surfaces.
12. Reassemble as necessary.
    NOTE: If system has automatic lubrication and feed, check to see that all lines are open before assembling.
13. Unlock power.

ENABLING OBJECTIVES:

1. Explain the relevant safety practices and procedures.
2. Identify the different types of grinders.
3. Identify the parts of a pedestal grinder and a surface grinder.
4. Describe how a surface grinder functions.
5. Explain available types of lubricants and their applications.
6. Explain calculation surface feed per minute.
7. Describe types and characteristics of various wheels.

8. Explain grit rating.
9. Describe various cutting fluids and their applications.

TASK # 8.1.2 Dress grinding wheel for grinding machine.

PERFORMANCE STANDARD: Wheel must be dressed to specifications, free of glaze and loadings, valleys and ridges.

TOOLS, RESOURCES, EQUIPMENT AND SITUATION(S):

Grinder (pedestal, bench, cylindrical w/tool post/ holding attachment)
Grinding machine manual
Grinding wheel dresser (diamond tool)
Personal safety equipment
6" scale
Wrenches (box, open end)

PERFORMANCE STEPS:

1. Inspect grinding wheel for damage.
   a. Ring test for cracks.
   CAUTION: DAMAGED WHEEL MUST BE REPLACED.
2. Select diamond point dresser.
3. Place dressing tool in tool post or holding attachment.
   NOTE: Varies with type of grinder, pedestal, bench, cylindrical.
4. Set speed of grinder at regular grinding rate.
5. Adjust depth of cut to remove glaze and loadings.
   a. Apply coolant/lubricant if necessary.
6. Stop wheel.
7. Check to specifications.
8. Start wheel.
9. Adjust depth of cut as necessary.
10. Stop wheel.
11. Check to specifiations.

ENABLING OBJECTIVES:

1. Explain the relevant safety practices and procedures.
2. Identify the parts and how they function for grinding operations.
3. Differentiate between loading, glazing, valleys, and ridges.
4. Describe various cutting fluids and lubricants utilized for dressing wheels.
5. Explain how to ring test wheels.
6. Explain how to maintain and care for a dressing tool.

TASK # 8.1.3 Change coolant in grinding machine.

PERFORMANCE STANDARD: Coolant must flow in steady stream, and must be clean and free from dirt and grit. Coolant must contain additive in accordance with specifications to prevent rusting of workpiece or grinding machine.

TOOLS, RESOURCES, EQUIPMENT AND SITUATION(S):

Coolant pail	Putty knife or scraper
Manufacturer's manual	Screwdriver
Personal safety equipment	Wrenches (open-end, socket)

PERFORMANCE STEPS:

1. Consult manufacturer's manual for type of grinder.
2. Turn on main power source of grinder.
3. Place pail under coolant hose nozzle.
4. Pump coolant from reservoir until empty.
5. Flush coolant system.
   a. Check connections for leaks.
6. Turn off coolant pump.
7. Turn off/lock out main power source of grinder.
   NOTE: Test for "off" condition.
8. Clean coolant reservoir.
   a. Use scraper if necessary.
9. Prepare coolant according to specifications.
10. Refill coolant reservoir to specifications.
11. Unlock power.
12. Test coolant system for flow.

ENABLING OBJECTIVES:

1. Explain the relevant safety practices and procedures.
2. Identify solvents that can be used with grinders.
3. Define additives for coolants.
4. Identify parts and functions of coolant flow system.

LEARNING OUTCOME # 8.2 Sharpen tools using grinder.

TASK # 8.2.1 Sharpen tools using grinder.

PERFORMANCE STANDARD: Tool bit must have sharp cutting edge free of craters, nicks or burn marks. Contour (shape) must conform to gauge or specifications.

TOOLS, RESOURCES, EQUIPMENT AND SITUATION(S):

Allen wrench	Honing stone
Angle gauges	Machinist's Handbook
Bevel protractor	Outside micrometer (1")
Contour gauges	Personal safety equipment
Drill relief gauge	Wheel dresser
Grinder,accessories	Wrenches, box/open end
Grinding wheel	

PERFORMANCE STEPS:

1. Select/mount grinding wheel.
   a. Ring test for cracks.
   b. Inspect for damage, uneven wear, ridges, valleys, glaze, loading, and out-of-round.
   c. Report or replace if necessary.
2. Dress wheel if necessary.
3. Determine desired profile (shape) of tool bit from Machinist's Handbook.
4. Adjust tool rest if necessary.
5. Start grinder (wheel rotation).
6. Apply coolant if necessary.
7. Sharpen tool bit to gauge or specifications.
8. Turn off grinder.
9. Turn off coolant if necessary.
10. Hone cutting edge.

ENABLING OBJECTIVES:

1. Explain the relevant safety practices and procedures.
2. Explain how to use the Machinist Handbook to determine shape and specifications for tool being sharpened.
3. Identify various types of grinders and their functions.
4. Identify various types and grits of wheels for grinders.
5. Explain the terms tempering and annealing.
6. Identify various types and grades of honing stones.
7. Describe testing and dressing grinding wheels.

LEARNING OUTCOME # 8.3 Deburr using hand grinder.

TASK # 8.3.1 Deburr using hand grinder.

PERFORMANCE STANDARD: Surface(s) must be smooth with no sharp corners and free of burrs in accordance with specifications.

TOOLS, RESOURCES, EQUIPMENT AND SITUATION(S):

- Allen wrench
- Bench vise
- Chuck key
- Extension cords (electricl or air)
- Face shield
- Hand grinder with deburring elements (stones, discs, deburring tools, etc.)
- Isolation curtain or shield
- Personal safety equipment
- Respirator

PERFORMANCE STEPS:

1. Determine area to be deburred.
2. Secure workpiece in vise.
3. Mount deburring element(s).
4. Attach power source.
5. Isolate grinding area with curtain or shield.
6. Start grinder.
7. Deburr workpiece to specifications.
8. Turn off grinder.
9. Check material for burrs.
10. Detach power source.
11. Put away workpiece.

ENABLING OBJECTIVES:

1. Explain the relevant safety practices and procedures.
2. Identify various types of hand grinders.
3. Identify the parts of a hand grinder.
4. Differentiate between stones, discs, and deburring tools.
5. Define deburring.
6. Identify lubricants and coolants available for deburring operation.
7. Identify grit ratings for stones and discs.

UNIT #9 Turning

LEARNING OUTCOME # 9.1 Bore hole and counterbore using lathe.

TASK # 9.1.1 Bore hole and counterbore using lathe.

PERFORMANCE STANDARD: Hole must have smooth finish free of chatter marks and depth must be within (+/-)1/64", diameter within (+/-)0.003", and location within (+/-)0.010".

TOOLS, RESOURCES, EQUIPMENT AND SITUATION(S):

- Adjustable wrench
- Boring bar and holder
- Cutting tools (sharpened)
- Engine lathe
- Lathe manual
- Machinery's handbook
- Micrometer
- Personal safety equipment
- Steel scale
- Telescope gauges

PERFORMANCE STEPS:

1. Chuck workpiece in lathe.
2. Select and set lathe speed.
   a. Repeat in steps 3-12 as needed.
3. Face and square workpiece.
4. Center drill workpiece.
5. Step drill workpiece to within 1/8" of bore diameter.
6. Select boring bar (large as possible).
7. Select boring tool.
   a. Check for sharpness.
   b. Check for clearance.
8. Mount boring bar with tool on center height.
9. Start lathe.
10. Move tool to workpiece and take light cut.
    a. Note end of cut on boring bar.
    b. Leave tool at cross slide setting when removing from cut.
11. Measure bored hole.
12. Take additional cuts until bored to designated dimension (Note cross feed readings are reverse of turning outside diameter).

ENABLING OBJECTIVES:

1. Explain the relevant safety practices and procedures.
2. Identify the parts of lathe.
3. Differentiate between terms boring and counterboring.
4. Describe drilling holes on lathe.
5. Describe mounting workpiece in universal three jaw chuck and four jaw independent chuck.
6. Identify sharpening bore cutter procedure.
7. Identify cutter feed rate and speed using Machinist Handbook.
8. Differentiate between ferrous and nonferrous material.

LEARNING OUTCOME # 9.2 Cut internal and external threads using lathe.

TASK(S) # 9.2.1 Cut internal threads using lathe.
9.2.2 Cut external threads using lathe.

TASK # 9.2.1 Cut internal threads using lathe.

PERFORMANCE STANDARD: Threads must be free of burrs and cut to specifications.

TOOLS, RESOURCES, EQUIPMENT AND SITUATION(S):

- Boring bar
- Engine lathe with attachments and accessories
- Lathe manual
- Machinery's handbook
- Personal safety equipment
- Scale
- Thread plug gauges
- Tool bit ground to thread form

PERFORMANCE STEPS:

1. Identify material of workpiece for section of drills, cutting speeds and feed.
2. Chuck workpiece in lathe.
3. Face workpiece.
4. Center-drill workpiece.
5. Step-drill as necessary.
   a. Lubricate as necessary.
6. Bore hole to minor diameter of threads.
7. Set compound rest to specifications.
8. Mount and square boring bar using center gauge.
9. Set up Quick-Change gear box.
10. Make thread dial selection.
11. Turn on lathe.
12. Cut threads to specifications.
13. Turn off lathe.
14. Check threads with thread plug gauge.
15. Remove workpiece.
16. Remove tool bit.

ENABLING OBJECTIVES:

1. Explain the relevant safety practices and procedures.
2. List limitations of cutting internal threads with boring bar.
3. Differentiate between various thread configurations, SAE-NC, SAE-NF, METRIC, PIPE, ACME, SQUARE DRIVE.
4. Explain sharpening cutter bit.
5. Explain rechasing threads.
6. Describe hand tapping on lathe.

TASK # 9.2.2 Cut external threads using lathe.

PERFORMANCE STANDARD: Threads must be free of burrs and cut to specifications.

TOOLS, RESOURCES, EQUIPMENT AND SITUATION(S):

Engine lathe with attachments and accessories	Personal safety equipment
	Thread center gauge
	Tool cutting bits (ground to proper thread form)
Lathe manual	
Machinist's Handbook	

PERFORMANCE STEPS:

1. Chuck workpiece in lathe.
2. Select and set speed (repeat in steps 3-12, as needed).
3. Face and center drill workpiece.
4. Secure workpiece between centers.
5. Set compound rest to thread specifications (29 or 30).
6. Mount and align cutter tool bit with gauge.
7. Set gear box and headstock gears.
8. Set lathe speed (slow).
9. Check movement of threading tool for length of work.
10. Start lathe.
11. Make thread dial selection.
12. Cut threads to specifications.
    a. Check pitch after first light cut.
    b. File burrs during threading operation.
    c. Use lubricant.
    d. Finish with light cuts.
    e. Check fit before completion of cuts.
13. Measure thread with GO and NO GO thread ring gauge.
    a. Accept workpiece, or
    b. Reject workpiece.

ENABLING OBJECTIVES:

1. Explain the relevant safety practices and procedures.
2. Demonstrate sharpening cutter bit procedure.
3. Describe using die cutters on lathe.
4. Explain rechasing threads.
5. Identify calculating cutting speed and feed rate using Machinist's Handbook.

LEARNING OUTCOME # 9.3 Drill hole and center drill hole using lathe.

TASK(S) # 9.3.1 Drill hole using lathe.
9.3.2 Center drill hole using lathe.

TASK # 9.3.1 Drill hole using lathe.

PERFORMANCE STANDARD: Hole must be free of burrs and chatter marks, and drilled according to specifications.

TOOLS, RESOURCES, EQUIPMENT AND SITUATION(S):

- Center drill
- Drill holder (optional)
- Engine lathe with attachments and accessories
- Headstock chuck or faceplate
- Lathe operator's manual
- Machinery's handbook
- Personal safety equipment
- Tailstock drill chuck or tapered shank drills
- Tool post
- Twist drill

PERFORMANCE STEPS:

1. Identify workpiece material for selection of cutting speeds/feeds.
2. Mount workpiece in chuck or on faceplate.
3. Face workpiece as necessary.
4. Select/set speed for center drilling.
5. Select/mount drill in tailstock using chuck or taper shank drill.
6. Start lathe spindle.
7. Center drill hole by applying pressure on tailstock.
8. Stop lathe.
   a. Select/mount drill.
9. Step drill hole by repeating steps #4 to #8 as necessary.
   a. Lubricate as necessary.
10. Shut off lathe.
11. Check hole to specifications.
12. Remove drill/attachments.

ENABLING OBJECTIVES:

1. Explain the relevant safety practices and procedures.
2. Identify cutter feed rate and speed using Machinist's Handbook.
3. Describe mounting workpiece in three jaw and four jaw chuck.
4. Identify cutting fluids available and their applications.
5. Explain step drilling.

TASK # 9.3.2 Center drill hole using lathe.

PERFORMANCE STANDARD: Size and location of the holes must be drilled to specifications.

TOOLS, RESOURCES, EQUIPMENT AND SITUATION(S):

- Combination drill and counter sink
- Cutting tool bits
- Drill chuck/center drill holder
- Engine lathe with attachments
- Lathe manual
- Machinery's handbook
- Personal safety equipment

PERFORMANCE STEPS:

1. Identify workpiece material for selection of cutting speeds and feed.
2. Secure workpiece in lathe chuck.
3. Face one end of workpiece.
4. Select/mount drill chuck and combination drill/ countersink in tailstock.
5. Select and set cutting speed of spindle.
6. Start lathe.
7. Drill/countersink hole to specifications.
8. Stop lathe.
9. Reverse workpiece in chuck.
10. Start lathe.
11. Face second end to length.
12. Drill/countersink second hole to specifications.
13. Stop lathe.
14. Remove workpiece.
    a. Re-check to specifications.
15. Remove drill chuck and drill from tailstock.

ENABLING OBJECTIVES:

1. Explain the relevant safety practices and procedures.
2. Identify purpose of center drilled holes.
3. Explain calculating center drill size.
4. Describe mounting workpiece in three jaw and four jaw chucks.
5. Identify technique for truing damaged center hole.
6. Sketch the shape of a spotting tool.
7. Explain cutting fluids for drilling.
8. Identify speed and rate of feed calculations.

LEARNING OUTCOME # 9.4 Face workpiece held in chuck on lathe.

TASK # 9.4.1 Face workpiece held in chuck on lathe.

PERFORMANCE STANDARD: Face of the workpiece must be smooth, true and square to axis of work in accordance with specifications.

TOOLS, RESOURCES, EQUIPMENT AND SITUATION(S):

- Dial indicator
- Engine lathe with attachments and accessories
- Four-jaw independent chuck
- Lathe manual
- Oil can with oil
- Personal safety equipment
- Shims
- Square
- Square cutting tool bits
- Three-jaw universal chuck

PERFORMANCE STEPS:

1. Identify workpiece material for selection of cutting speeds and feed.
2. Clean and lightly oil threads on lathe spindle.
   NOTE: Some lathes have com-lock type spindle.
3. Clean threads (or cam-stud) in chuck.
4. Mount chuck on lathe spindle.
5. Mount workpiece in chuck.

   Three-Jaw Universal Chuck.

   a. Check and adjust for true running with shims as necessary.

   Four-Jaw Independent Chuck.

   a. Adjust for true running by using dial indicator.

6. Mount cutting tool bit in tool holder.
   a. Adjust as necessary.
7. Adjust cutting tool bit to center of workpiece.
8. Lock carriage to bed.
9. Select and set speed and feed.
   a. Small pieces. Hand feed.
   b. Large pieces. Use power cross-feed.
10. Face material to specifications.
11. Shut off lathe.
12. Remove workpiece

ENABLING OBJECTIVES:

1. Explain the relevant safety practices and procedures.
2. Identify various styles of cutter for lathe.
3. Identify feed rate and speed using machinist's handbook.
4. Describe how to grind and hone cutter bits.
5. Explain workpiece mounting techniques for four-jaw chucks and collet chucks.
6. Identify cutting fluids and their applications.

LEARNING OUTCOME # 9.5 Cut external taper on lathe using compound rest.

TASK # 9.5.1 Cut external taper on lathe using compound rest.

PERFORMANCE STANDARD: Taper surface must be smooth, free of chatter marks, and cut according to specifications.

TOOLS, RESOURCES, EQUIPMENT AND SITUATION(S):

Cutting tool	Lathe manual
Dial indicator	Machinist's Handbook
Drill chuck	Micrometer
Drills	Personal safety equipment
Engine lathe with attachments and accessories	Taper gauge
	Vernier bevel protractor

PERFORMANCE STEPS:

1. Identify material of workpiece for selection of cutting speeds and feed.
2. Chuck workpiece on lathe.
3. Select and set speed for facing.
4. Face workpiece and center drill.
5. Reverse ends of workpiece face to length and center drill.
6. Mount workpiece between centers.
7. Set compound rest to specifications with dial indicator and vernier bevel protractor.
8. Mount, adjust and secure cutting tool.
9. Make rough cut.
10. Measure workpiece and adjust cutting tool and compound rest as necessary.
11. Select and set spindle speed for finish cuts.
12. Finish cut to specifications.

ENABLING OBJECTIVES:

1. Explain the relevant safety practices and procedures.
2. Identify cutter bits and their cutting applications.
3. Identify feed rate and spindle speed using Machinist Handbook.
4. Explain how to convert taper into degree for setting compound rest.
5. Describe other techniques for cutting external taper, taper attachment, and offsetting tail.

LEARNING OUTCOME # 9.6 Cut off workpiece held in chuck using parting tool.

TASK # 9.6.1 Cut off workpiece held in chuck using parting tool.

PERFORMANCE STANDARD: Surfaces of finished workpiece(s) must be smooth, free of chatter marks and burrs, and cut to specifications.

TOOLS, RESOURCES, EQUIPMENT AND SITUATION(S):

Cut-off or parting tool bit and cut-off blade	Lathe manual
Cutting tool bit	Machinist's Handbook
Engine lathe with attachments and accessories	Micrometer
	Personal safety equipment
	Scale
	Tool holder

PERFORMANCE STEPS:

1. Identify metal stock for selection of cutting speed and feed.
2. Mount stock in chuck.
3. Face and square stock.
4. Mount and secure cut-off tool bit.
5. Select and set cutting speed for spindle.
6. Select and set feed rate on power cross-feed.
7. Make light parting cut and check length.
8. Cut workpieces to specifications.
   a. Deburr as necessary.
9. Check measurements to specifications.
10. Remove stock.

ENABLING OBJECTIVES:

1. Explain the relevant safety practices and procedures.
2. Describe how to sharpen and hone a parting tool bit.
3. Identify feed rate and spindle speed using Machinist Handbook.
4. Explain deburring procedure.
5. Describe techniques for turning between centers.
6. Describe mounting workpiece in collet chuck and three-jaw chuck.

UNIT #10	Maintain Equipment	
LEARNING OUTCOME #	10.1	Inspect and troubleshoot linkages, lever mechanisms, drive couplings, clutches, and roller ball bearings on machines.
TASK(S) #	10.1.1	Inspect and troubleshoot linkages and lever mechanisms.
	10.1.2	Inspect and troubleshoot drive couplings.
	10.1.3	Inspect and troubleshoot clutches.
	10.1.4	Inspect and troubleshoot roller ball bearings.
TASK #	10.1.1	Inspect and troubleshoot linkages and lever mechanisms.
PERFORMANCE STANDARD:		Faulty, worn or damaged parts must be identified, repaired or replaced and machines must operate in compliance with manufacturer's specifications. Part(s) must be tagged for repair, replacement, or discard.

TOOLS, RESOURCES, EQUIPMENT AND SITUATION(S):

- Inventory of replacement
- Maintenance mechanic's tool box (hand tools)
- Manufacturer's specifications
- Personal safety equipment
- Plant/shop policy/procedures for disassembly/repair/replacement/discard
- Wiping rags

PERFORMANCE STEPS:

1. Lock out equipment power.
2. Check plant/shop procedures for authorized field assembly/disassembly and repair/replacement/discard of parts.
3. Check machine/equipment manuals for authorized field assembly/disassembly and repair.
4. Inspect linkages and levers.
   a. Look for damaged, bent or broken parts.
   b. Look for stripped threaded parts pulled apart.
   c. Look for worn parts/connections, elongated holes, stripped splines.
5. Unlock/run the equipment/machine and determine cause for distorted, worn and broken parts.
6. Check with supervisor on plant/shop capabilities to repair/replace the part(s) and urgency for maintaining production schedules.
   NOTE: It may be more cost-effective to get/keep machine operational and eliminate cause of breakdown later.
7. Lock out power.
   a. Replace/repair/discard the broken and/or distorted parts in accordance with manufacturer's manuals, shop practice, and supervisor's recommendations.
8. Unlock/run the machine and adjust linkages and levers according to manufacturer's specifications.
9. Eliminate cause of breakdown/malfunction as necessary, if not accomplished in step #7.
10. Tag part(s) for repair, replacement, or discard.

ENABLING OBJECTIVES:

1. Explain the relevant safety practices and procedures.
2. Visually identify linkage and lever mechanisms.
3. Identify function of linkage and lever mechanism.
4. Differentiate between damaged and normal set up with aid of manufacturer's specifications.

TASK # 10.1.2 Inspect and troubleshoot drive couplings.

PERFORMANCE STANDARD: Worn and broken parts not in compliance with manufacturer's operating specifications must be identified and decision for repair, replacement, or discard must have been made.

TOOLS, RESOURCES, EQUIPMENT AND SITUATION(S):

- Inventory of replacement parts
- Maintenance mechanics tool box (hand tools)
- Manufacturer's specifications
- Personal safety equipment
- Plant/shop policy/procedures for disassembly/repair/replacement/discard
- Wiping rags

PERFORMANCE STEPS:

1. Lock out equipment power.
2. Check plant/shop procedures for authorized field assembly/disassembly repair/replacement/discard.
3. Check machine/equipment manuals for repair/disassembly.
4. Disassemble machine/mechanism to expose drive coupling as necessary.
5. Remove all grease and dirt from coupling.
6. Inspect the coupling for freedom of operation.
7. Check for broken parts, wear, or damage.
8. Determine cause of breakdown/malfunction.
9. Check with supervisor on plant/shop capabilities to repair/replace the part(s) and urgency for maintaining production schedules.
   NOTE: It may be more cost-effective to get/keep equipment operational and eliminate cause of breakdown later.
10. Replace, repair, discard part(s) in accordance with manufacturer's manuals, shop practice and supervisor's recommendations.
11. Check coupling for correct operation according to manufacturer's specifications.
12. Eliminate cause of breakdown/malfunction as necessary, if not accomplished in step #10.
13. Tag parts for repair, replacement, or discard as necessary.

ENABLING OBJECTIVES:

1. Explain the relevant safety practices and procedures.
2. Describe the parts and functions of drive couplings.
3. Identify lubricants and cleaning solvents recommended by manufacturer.
4. Differentiate between damaged, worn, and normal setup with aid of manufacturer's specifications.
5. Identify causes of coupling malfunction.

TASK # 10.1.3 Inspect and troubleshoot clutches.

PERFORMANCE STANDARD: Worn and broken parts not in compliance with manufacturer's specifications must be identified and decision for repair, replacement, or discard must have been made.

TOOLS, RESOURCES, EQUIPMENT AND SITUATION(S):

- Inventory of replacement parts
- Maintenance mechanic's tool box (hand tools)
- Manufacturer's specifications
- Personal safety equipment
- Plant/shop policy/procedures for disassembly/repair/replacement/discard
- Wiping rags

PERFORMANCE STEPS:

1. Lock out equipment power.
2. Check plant/shop procedures for authorized field assembly/disassembly repair/replacements/discards of parts.
3. Check machine/equipment manuals for authorized field assembly/disassembly repair.
4. Disassemble machine/mechanism to expose clutch or brake as necessary.
5. Remove all grease and dirt from clutch or brake.
6. Inspect item for correct operation according to manufacturer's specifications.
7. Inspect for wear/damage or broken parts.
8. Determine cause of breakdown/malfunction.
9. Check with supervisor on plant/shop capabilities to repair/replace the part(s) and urgency for maintaining production schedules.
   NOTE: It may be more cost-effective to get/keep equipment operational and eliminate cause of breakdown later.
10. Replace/repair/discard part(s) in accordance with manufacturer's manuals, shop practice, and supervisor's recommendations.

11. Clean parts before reassembly.
12. Eliminate cause of breakdown/malfunction as necessary, if not accomplished in step #10.
13. Tag parts for repair, replacement, or discard as necessary.

ENABLING OBJECTIVES:

1. Explain the relevant safety practices and procedures.
2. Describe the function of a clutch.
3. Identify the parts and function of parts of a clutch system.
4. Identify lubricants and solvents used with clutch mechanisms.
5. Differentiate between damaged, worn, and normal clutch parts.
6. Identify causes of clutch mechanisms malfunctions.

TASK # 10.1.4 Inspect and troubleshoot roller ball bearings.

PERFORMANCE STANDARD: Bearings not in compliance with manufacturer's operating specifications must have been identified, and cause of damage determined. Bearings must be tagged for repair, discard.

TOOLS, RESOURCES, EQUIPMENT AND SITUATION(S):

- Inventory of replacement parts
- Maintenance of mechanic's tool box (hand tools)
- Manufacturer's specifications
- Personal safety equipment
- Plant/shop policy/procedures on disassembly/repair/replacement/discard
- Vibration detector
- Wiping rags

PERFORMANCE STEPS:

1. Lock out equipment power.
2. Check plant/shop procedures for authorized field assembly/disassembly and repair/replacement/discard of parts.
3. Check equipment manuals for authorized field assembly/disassembly and repair.
4. Disassemble machine/mechanism to expose areas containing bearings as necessary.
5. Remove bearings from shafts as necessary.
6. Remove all grease and dirt from bearing.
7. Inspect bearing for freedom of rotation.
8. Inspect bearing for smooth operation with vibration detector.
9. Inspect for wear markings and damage.
10. Determine cause of breakdown/malfunction.

11. Check with supervisor on plant/shop capabilities to repair/replace the part(s) and urgency for maintaining production schedules.
12. Replace/repair/discard part(s) in accordance with manufacturer's manuals, shop practice, and supervisor's recommendations.
13. Eliminate cause of breakdown/malfunction as necessary.
14. Tag the bearings for repair/replacement/discard.

ENABLING OBJECTIVES:

1. Explain the relevant safety practices and procedures.
2. Identify parts of roller ball bearings.
3. Identify causes of bearing damage.
4. Explain function of roller ball bearings.
5. Explain alignment and shimming procedures.
6. Identify lubricants for roller ball bearings.
7. Visually identify damage roller ball bearings.

LEARNING OUTCOME #	10.2	Inspect and troubleshoot gear box drives, belt/variable speed drives, chain drives, and open gear drives on machines.
TASK(S) #	10.2.1	Inspect and troubleshoot open gear/gear box drives.
	10.2.2	Inspect and troubleshoot belt/variable speed drives.
	10.2.3	Inspect and troubleshoot chain drives.
TASK #	10.2.1	Inspect and troubleshoot open gear/gear box drives.

PERFORMANCE STANDARD: All worn and damaged parts not in compliance with manufacturer's operating specifications must have been identified, decision to repair, replace, or discard must have been made, and mechanism must operate in accordance with manufacturer's specifications.

TOOLS, RESOURCES, EQUIPMENT AND SITUATION(S):

- Arbor press
- Bearing pullers
- Inventory of replacement parts
- Maintenance mechanic's tool box (hand tools)
- Personal safety equipment
- Plant/shop policy/procedures for disassembly/repair/replacement/discard
- Wiping rags

PERFORMANCE STEPS:

1. Lock out equipment power.
2. Check with supervisor or plant/shop procedures for authorized field assembly/disassembly repair, replacement/discard of parts.
3. Check machine/equipment manuals for authorized field assembly/disassembly.
4. Disassemble mechanism to expose gear box drive as necessary.
5. Remove grease and dirt from gear box.
   a. Drain oil.
6. Dismantle gear box and remove gears and bearings.
7. Clean and check bearings for wear, damage, smoothness, and freedom of operation.
8. Clean and check gears.
   a. Check for missing teeth, worn gaskets (cover seals).
   b. Check teeth for excessive wear and damage according to manufacturer's specifications.
   c. Check for worn keyways, keys, and bores.
9. Determine causes of damage/excessive wear/breakdown/malfunction.
10. Check with supervisor on plant/shop capabilities to repair/replace part(s) and urgency for maintaining production schedules.
    NOTE: It may be more cost-effective to get/keep machine/equipment operating as soon as possible and eliminate cause of breakdown later.

ENABLING OBJECTIVES:

1. Explain the relevant safety practices and procedures.
2. Identify parts of gear box and open gear drive.
3. Visually identify damaged gears.
4. Identify lubricants for gear drives.
5. Explain gear alignments and meshing requirements.
6. Describe various gear shapes and designs.
7. Identify causes of gear failure.

TASK # 10.2.2 Inspect and troubleshoot belt/variable speed drives.

PERFORMANCE STANDARD: All worn and damaged parts not in compliance with manufacturer's specifications must have been identified, decision to repair, replace, or discard must have been made and mechanism must operate according to manufacturer's specifications.

TOOLS, RESOURCES, EQUIPMENT AND SITUATION(S):

- Inventory of parts
- Maintenance mechanic's tool box (hand tools)
- Manufacturer's specifications
- Personal safety equipment
- Plant/shop policy/procedures for disassembly/repair/replacement/discard
- Wiping rags

PERFORMANCE STEPS:

1. Lock out machine power.
2. Check plant/shop procedures for authorized field assembly/disassembly and repair/replacement/discard of parts.
3. Check machine/equipment manuals for authorized field assembly/disassembly repair.
4. Remove guards if necessary.
5. Remove grease and dirt from belt drive.
6. Inspect belts for wear, damage, and tension.
7. Inspect pulleys and bearings for damage and wear.
8. Determine causes of excessive wear and damage to parts.
9. Check with supervisor on plant/shop capabilities to repair/replace part(s) and urgency for maintaining production schedules.
   NOTE: It may be cost-effective to get/keep machine operational and eliminate cause of breakdown later.
10. Replace/repair/discard part(s) in accordance with manufacturer's manuals, shop practice and supervisor's recommendations.
11. Replace guards.
12. Start machine and check operation according to manufacturer's specifications.
13. Eliminate cause of breakdown/malfunction as necessary, if not accomplished in step #10.
14. Tag parts for repair, replacement, or discard as necessary.

ENABLING OBJECTIVES:

1. Explain the relevant safety practices and procedures.
2. Describe techniques for tensioning belt drives.
3. Identify causes of belt damage.
4. Identify lubricants for belts.
5. Describe pulley alignment and shimming.
6. Describe procedure for inspecting and repairing bearings.

TASK # 10.2.3 Inspect and troubleshoot chain drives.

PERFORMANCE STANDARD: All worn and damaged parts not in compliance with manufacturer's specifications must have been identified,decision to repair, replace, or discard must have been made, and machine must operate according to manufacturer's specifications.

TOOLS, RESOURCES, EQUIPMENT AND SITUATION(S):

- Inventory of parts
- Maintenance mechanic's handbook (hand tools)
- Manufacturer's specifications
- Personal safety equipment
- Plant/shop policy/procedures for disassembly/repair/replacement/discard
- Wiping rags

PERFORMANCE STEPS:

1. Lock out machine power.
2. Check plant/shop procedures for authorized field assembly/disassembly repair/replacement/discard of parts.
3. Check machine/equipment manuals for authorized field assembly/disassembly repair.
4. Remove guards as necessary.
5. Remove master link and chain.
6. Clean and inspect chain for broken/worn parts.
7. Inspect sprockets for broken/worn teeth in accordance with manufacturer's specifications.
8. Determine causes of excessive wear and damage.
9. Repair/replace/re-install/reassemble drive/discard parts as necessary in accordance with manufacturer's manuals. shop practice, and supervisor's recommendations.
10. Check with supervisor on plant/shop capabilities to repair/replace part(s) and urgency for main-

10. Check with supervisor on plant/shop capabilities to repair/replace part(s) and urgency for maintaining production schedules.
    NOTE: It may be more cost-effective to get/keep machine operational and eliminate cause of breakdown later.
11. Adjust chain tension to manufacturer's specifications.
12. Replace guards.
13. Start machine and check operation in accordance with manufacturer's specifications.
14. Eliminate cause of breakdown/malfunction as necessary, if not accomplished in step #9.
15. Tag parts for repair, replacement, or discard as necessary.

ENABLING OBJECTIVES:

1. Explain the relevant safety practices and procedures.
2. Identify parts chain drives.
3. Identify lubricants for chain drives.
4. Describe procedure for aligning sprockets.
5. Identify causes of chain drive damage.

INDUSTRIAL EQUIPMENT MAINTENANCE
STANDARD TOOL KIT

Maintenance Mechanic's Tool Box (Hand Tools)

Calipers, hermaphrodite
Calipers, inside
Calipers, outside
Calipers, vernier
Chisels, assorted, steel cold
Dial indicators
Feeler gauges (set)
Files, assorted
Flashlight, safety, 2 cell
Hacksaw
Hammer, ball peen
Hammer, chipping
Mallet, rubber
Micrometer, external 1"
Micrometer, internal
Micrometer, depth
Pliers, needlenose
Pliers, regular
Pliers, side cutter
Punches, center, set of 4
Punches, pin, set of 4
Safety locking block
Scale, 6" steel
Screwdrivers, assorted, flat
Screwdrivers, phillips, assorted
Screw extractor set
Scribes
Shim stock, assorted
Straightedge 1/4" x 1" x 24"
Spirit level
Square, combination
Tags, safety
Tape, 10 foot steel measuring
Vise grips
Wrenches, allen, assorted
Wrenches, hex box/open end, 1/4"-1"
Wrenches, adjustable 6"-12"
Wrenches, pipe, 6"-12"
Wrenches, socket, 3/8" drive
Wrenches, socket, 1/2" drive

Maintenance Mechanic's Personal Safety Equipment (PSE)

Safety glasses
Safety toe shoes
Hard hat
Gloves